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SCIENCE ABSTRACTS

SECTION A.—PHYSICS.

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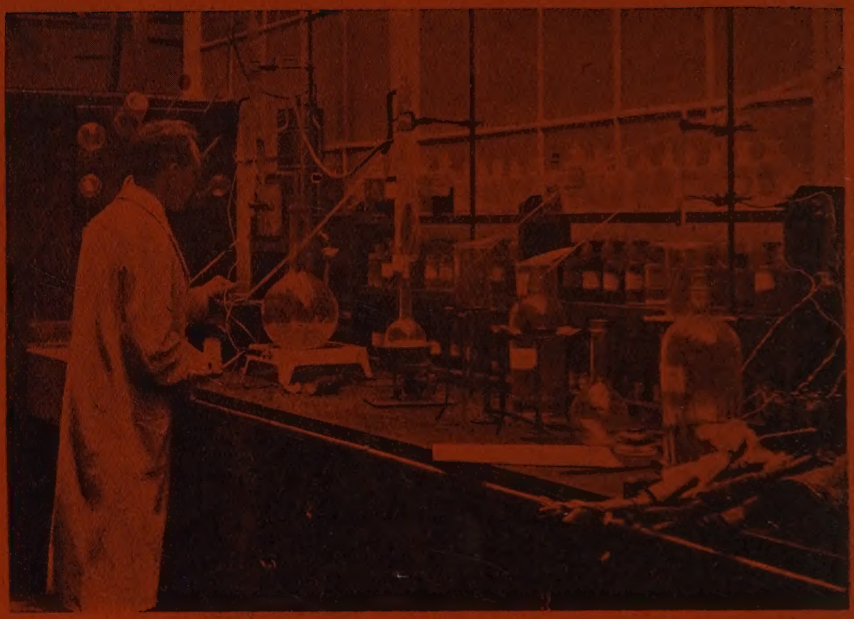

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SCIENCE ABSTRACTS.

Section A.—PHYSICS.

SEPTEMBER 1922.

GENERAL PHYSICS.

1934. *Method of Determining the Effective Surface-area of Absorbent Powders.* **F. Paneth.** (Zeits. Elektrochem. 28. pp. 113–115, March 1, 1922. Paper read at the Deut. Bunsen Gesell., Jena, Sept., 1921.)—In the theoretical study of adsorption it is desirable to have an accurate knowledge of the effective area of adsorbing surface. The author now describes such a method and applies it in the case of suspensions of lead chromate and lead sulphate. Thorium B (isotopic with lead) is used as the substance to be adsorbed, its presence and amount being determined by well-known radio-active methods. A. B. W.

1935. *Irregular Extension of Nickel and Steel.* **M. Cantone.** (Accad. Lincei, Atti, 31. i. pp. 414–420, May 21, 1922.)—Describes the results of a series of experiments on the behaviour of Ni and steel under tension. While Au and Sn show a perfectly regular progressive extension on the application of the load, the metals in question show a discontinuous extension curve, proceeding in small steps, or jerks. Reproductions of the curves actually obtained are given in the paper. J. W. T. W.

1936. *Further Investigations of the Laws of Fluid Resistance.* **C. Wieselsberger.** (Phys. Zeits. 23. pp. 219–224, May 15, 1922.)—Continues investigations [see Abstract 18 (1922)] upon the dependance of the resistance coefficient, c, and the Reynolds number, R, for the flow of a fluid past an obstacle. Results are given for short cylinders, spheres, circular discs, and flat plates. The value of c for short cylinders is markedly less than for infinitely long ones, below the critical number, being nearly halved as the aspect ratio is reduced from ∞ to 1. The critical number is also reduced, from 500,000 to 400,000. The curve exhibiting the dependance of c on R for the sphere has the same general form as that for the cylinder, with a critical number about 250,000. The formulæ of Stokes and Oseen cease to represent the results if R is greater than 1. The value of c for the circular disc remains practically constant over the range studied (R from 3000 to 1,000,000). For the flat plate, c diminishes with diminishing aspect ratio, but more quickly than for cylinders.
W. G. B.

1937. *Effect of Electric Field on Surface Tension.* **E. Perucca.** (N. Cimento, 23. pp. 191–198, Feb., March, April, 1922.)—Describes experiments made to determine the amount of alteration in surface tension of a liquid dielectric under the action of a powerful electric field. The dielectric used was vaseline oil, which was allowed to drop from the end of a fine tube. The size of the drops formed under a constant pressure was measured (*a*) without a field, (*b*) with a field of nearly 5000 volts/cm. The effect was found to increase from less than the experimental error (0·5 per cent.) to 1·8 per cent. with decrease in the tube diameter from 2 to 0·45 mm. The author suggests the use of a cylinder of the liquid, held between a tube and a rod, and exposed to the electric field, would, by measurement of the difference in the curvature of the two sides, give a more sensitive indication of the effect. J. W. T. W.

1938. *Grating Structure of the Oxides of the Alkali Earths.* **W. Gerlach.** (Zeits. f. Physik, 9. 3. pp. 184–192, 1922.)—An investigation of the structure of the oxides of the alkaline earths (Be, Mg, Ca, Sr, Ba) is described. The method employed is that of Debye and Scherrer, in which the powdered material is examined by homogeneous X-rays. The author finds that the structure of these substances is of the NaCl type, i.e. a regular face-centred lattice. The values of specific gravity of these substances calculated from the X-ray data are in very good accord with those obtained by ordinary direct methods. A. B. W.

1939. *Dynamic Allotropy of Tellurium.* **A. Damiens.** (Comptes Rendus, 174. pp. 1344–1346, May 22, 1922.)—To test the applicability of the theory of an alleged "dynamic" allotropy of tellurium (developed by Cohen and Kröner) to an explanation of its physical properties, the density of tellurium produced by various methods is determined under varying conditions. The results obtained do not require for their interpretation any such new theory, but point to the facts that tellurium possesses but one density corresponding to its most compact crystalline form, and that, contrary to the conclusions of Cohen and Kröner, the physical constants of tellurium retain their ordinary standard significance.
A. B. C. L.

1940. *The Atomic Nucleus.* **R[ita] Brunetti.** (N. Cimento, 22. pp. 215–241, Nov.–Dec., 1921.)—A study of the atomic or positive nucleus, based upon the work of Barkla, Rutherford, C. T. R. Wilson, van den Broek, Bohr, Moseley, Marsden, J. J. Thomson, and Aston. The paper is very suggestive, but the author abstains from drawing up any new scheme. A. D.

1941. *Structure of the Atom and the Physical and Chemical Properties of the Elements.* **N. Bohr.** (Zeits. f. Physik, 9. 1 and 2. pp. 1–67, 1922. Trans. of a lecture delivered before the Phys. and Chem. Societies of Copenhagen, Oct. 18, 1921.)—Outline, in four sections, of the tendencies of modern research and of their theoretical difficulties. I. According to the old mechanics and electrodynamics the Rutherford atom would not possess any stable equilibrium positions, and any movement would lead to the emission of radiation, finally causing the electrons to fall into the nucleus. With the aid of two postulates the quantum theory

helps over these difficulties. (1) There are certain stationary states of the atom during which the atom need not radiate, even if the particles be in accelerated motion, and any energy E gained or lost causes the atom to pass into another such state; (2) every radiation emitted during such a transition consists of a train of harmonic waves, depending not directly upon the atom, but upon $h\nu = E_I - E_{II}$. In the simplest possible atom (hydrogen) the Balmer lines correspond to stationary states, and the nth state is determined by $E_n = -Kh/n^2$, where K is an arbitrary constant. If we disregard, for the present, that the nucleus will itself participate in the movement, the electron will describe an ellipse about the nucleus occupying the one focus; the major axis of this ellipse is $2a_n = n^2e^2/Kh$. We may say that the hydrogen of spectrum teaches us that the stationary states represent steps in the process of binding the electron, under emission of radiation, to orbits of decreasing dimensions and decreasing n. Electrodynamics would have done that too, but it could not explain the properties of hydrogen, nor the fact that there is a limit condition for the atom of minimum energy, the normal state, when $n = 1$. The dimensions of the atom so deduced agree with other data; but the formulæ cannot really be checked, because such experimental investigations deal with molecules, not atoms. The stationary states can be defined by quantum numbers n. For a simple periodic movement a simple quantum number is sufficient to fix the energy and the major axis $2a$, but not the eccentricity. When the nucleus charge $Ne = 1$, $K = 2\pi^2e^4m/h^3$. When we have $2e$ (helium), K becomes 4 times as large; the corresponding spectrum was first ascribed to hydrogen, but it really represents the binding of a first electron by a nucleus of double charge.

II. The successive catching by the nucleus of N electrons takes place in N stages. In the case of elements of higher atomic weights we mostly know only the arc spectrum and the spark spectrum, and the frequencies of the lines are given by the differences of "terms" (combination principle of Ritz), which the quantum theory interprets. There are several series of stationary states (one series only for H and He). The arc spectra are connected with the (N − 1)th stage, the spark spectra with the last Nth stage of the neutral atom. The more electrons, the more rapid the rotation superposed upon the elliptic orbit, which will itself more and more deviate from an ellipse. But the n and k do not really account for all the lines of the sharp, principal, etc., series, as is shown with respect to the sodium spectrum. By the "correspondence principle," however, the author connects the radiations of the different transition states with the harmonic oscillations of the atom somewhat on the lines of the harmonic overtones. This principle enables us also to trace the Stark-effect in the hydrogen lines (and the explanation suggested by Epstein and Schwarzschild) back to orbit perturbations. For the complex and anomalous Zeeman-effect (Paschen and Back) a third quantum number (in addition to n and k) seems to be required.

III. The author explains at some length how the electrons are successively bound in the VII groups of the periodic table, to move in orbits of n_k quanta. If the end members of the groups and their atomic (ordinal) numbers are helium 2, neon 10, argon 18, krypton 36, xenon 54, niton 86, and if finally the hypothetical end member of group VII have the number 118, then we should have 1_1 orbits, 2_1 and 2_2 orbits, etc., 6_1, 6_2, 6_3, 6_4, 6_5, 6_6 orbits, and finally 7_1, 7_2, 7_3 orbits. The binding of

the second electron of helium may take place in two ways; hence the spectra of ortho-helium and of parhelium. By bombarding the He atom with electrons, Franck has transformed this atom into a "metastable" condition, from which the atom cannot return to the normal state simply by radiation, but can do so by chemical reaction, in the presence of foreign atoms. The normal state corresponds to a 1_1 orbit, the metastable state to a 2_1 orbit. The author had originally assumed that the two electrons might describe the same approximately circular path; that is impossible, and the planes of the two "central" orbits are probably inclined to one another at 120°. It is further important that the 4th and 5th electrons, like the 3rd, will, at some points of their orbits, penetrate into the domains of the two electrons (and others) first bound; the different groups of electrons are coupled, and not independent of one another. With the acquisition of the 7th electron the original symmetry will moreover no longer be maintainable.

IV. The discussion of Röntgen-spectra deals with the changes produced in the state of the atom by the absorption of radiation and the radiation processes thereby called forth, chiefly after Kossel, Sommerfeld, Smekal, and Coster, and with respect to the "level" (*Niveau*) differences. H. B.

1942. *Physical Notes on Solid and Gaseous Explosives.* **R. Becker.** (Zeits. techn. Physik, 3. 5. pp. 152–159, and 3. 7. pp. 249–256, 1922.)—Lecture on the phenomena of detonation, on the determination of the speed with which the detonation advances in the explosive, and on the fundamental equations of combustion and detonation. H. B.

1943. *The Differential Equation Satisfied by Airy's Stress-Function, and its Application to several Problems in Elasticity.* **K. Hayashi.** (Kyushu Univ. Coll. Eng., Mem. 2. 4. pp. 213–239, 1922.)—The paper is mainly mathematical. After a preliminary discussion of the differential equation satisfied by the stress-function and the stress components in an elastic plate, solutions for several distributions of traction on the straight edge of a semi-infinite plate are worked out, and graphs of stresses and lines of principal stress given. W. G. B.

1944. *Absorption of Gravitation.* **Q. Majorana.** (Accad. Lincei, Atti, 30. ii. pp. 75–79, Aug.; 350–354, Nov. 6, and pp. 442–446, Dec. 4, 1921.)—Heavier masses now used, and successive modifications introduced, Sources of error removed and, it is thought, definite results now obtained. A mass of 9603 kg., shielded from gravitation by a mass of about 10 tons, suffers a loss of weight of 0·002 mg., instead of 0·005 mg. calculated. [See Abs. 802 (1920).] A. D.

1945. *Absorption of Gravitation.* **Q. Majorana.** (Accad. Lincei, Atti, 31. i. pp. 41–45, Jan. 22; 81–86, Feb. 5; 141–146, Feb. 19; 221–226, April 2, and pp. 343–346, May 7, 1922.)—Description of experimental details; discussion and evaluation of possible errors; alternative methods. The final result is that a sphere of lead of 1274 grammes surrounded by a mass of 9616 kilograms of lead weighs less by $\{0.00201 \pm 0{\cdot}00010\}$ milligrams; which gives an absorption-coefficient $h = (0{\cdot}000002$ grm.) $\div \{(m = 1274$ grms.) (ρ surrounding mass $= 11{\cdot}33$) (mean thickness of shielding mass traversed by the gravitation-rays $= 50$ cms.)$\} = 2{\cdot}8 \times 10^{-12}$

per unit of mass acted on, per unit of density and per unit of thickness of the shielding mass. [Abs. 1521 (1921) and preceding Abstract.]
A. D.

1946. *Geometry of Curved Spaces.* **E. Bompiani.** (Comptes Rendus, 174. pp. 737–740, March 13, 1922.)—Reference is made to a construction by E. Cartan [see Abs. 1059 (1922)] on Einstein's "energy-tension," which is compared with the notion of parallelism of Levi-Cività. The development is mainly mathematical. A. B. C. L.

1947. *Conception of Space according to the Theory of Relativity.* **S. Zaremba.** (Comptes Rendus, 174. pp. 1416–1418, May 29, 1922.)—In development of an argument by J. Le Roux [see Abs. 1484 (1922)] in which the limitations of possible interpretation of the results of the theory of relativity are discussed, it is further argued that it is not permissible to attribute any meaning to the assertions of the theory of relativity in relation to the nature of space. A. B. C. L.

1948. *Sagnac's Researches in Relation to Relativity Theory.* **R. Ortvay.** (Phys. Zeits. 22. pp. 176–178, April 15, 1922.)—Sagnac has described a series of researches dealing with the passage of light through an interferometer system in rapid rotation [Abs. 65, 216, and 1506 (1914)]. Theoretical treatment relative to a system stationary with respect to the earth has been given by v. Laue [Abs. 1403 (1920)]. The present paper deals with the subject from the relativity standpoint. It is shown that the gravitational forces proceeding from rotating distant masses take the light in the direction of motion. In a system of coordinates rotating with respect to the fixed-star system it is to be expected that a light motion will occur corresponding to that observed by Sagnac.
A. W.

1949. *The Velocity of a Light Ray in a Moving Body.* **M. v. Laue.** (Zeits. f. Physik, 10. 2. pp. 89–90, 1922.)—Two different methods exist on the limited relativity theory for transforming the direction and velocity of a light ray in a body: one introduced by the author and based on Einstein's addition theorem, the other deriving energy, tensions, and the energy stream for a reference system and then making a transformation as components of a world tensor. W. Pauli, Jr., has compared the results by both processes, and found that the second contradicts the first when the energy-impulse tensor for Maxwell's electrodynamics of the body is chosen symmetrically by Abraham's procedure and the ray-velocity introduced by the equation, $w = S/W$, where S is Poynting's vector and W the energy density. If the unsymmetrical tensor of Minkowski be substituted in its place, the contradiction is found to disappear. The present author now shows that the above definition of the ray velocity on Abraham's procedure is insufficient, at least when S and W are regarded as purely electromagnetic energy magnitudes, and that a distinction cannot thus be made between the energy-impulse tensors of Minkowski and Abraham. H. H. Ho.

1950. *The Significance of the Null-Cone in the General Theory of Relativity.* **M. v. Laue.** (Preuss. Akad. Wiss. Berlin, Ber. 13. pp. 118–

126, 1922.)—The null-cone, which separates from its apex outwards all directions of a space-time character, finds the physical justification for this mathematical conception in the facts that its products, viz. the geodetic null lines, represent the propagation of the electromagnetic effects. In addition they correspond to the light rays, and actually this statement based on the limited relativity theory may be transferred to the general theory [see Abs. 419 (1921)]. The ray conception is an approximation which finds expression in this transformation. The present paper deals with the multifold significance of the null-cone, seeking for it a rigid basis from the natural laws. The whole of the paper is mathematical. H. H. Ho.

1951. *On the Problem of the Physical Significance of the Relativity Theory.* **N. v. Raschevsky.** (Zeits. f. Physik, 10. 4. pp. 209–226, 1922.) —In a series of recent communications, Guillaume [Abs. 591 (1921)] has made the attempt to give a physical interpretation to the conclusions of the relativity theory in the sense of the classical representations of space and time. In his considerations, Guillaume assumed the principle of the constant velocity of light and its independence of the velocity of the light emitting source. In addition to this constant light velocity, Guillaume introduced a momentary transition velocity at the instant of the light emission, whose physical conception offers certain difficulties. Guillaume concluded that the relativity theory does not give true but apparent motions with aberrations. The connection between the apparent and true velocities has not yet been determined. The hodograph of the momentary light velocity is an ellipsoid of rotation, with the major axis parallel to the direction of translation and the light source at the rear focus. The transition velocity, however, has to be regarded as pure fiction. The object of the present paper is to give a physical interpretation of the relativity theory. Paschsky [Abs. 1280 (1922)] has attempted to establish the electrodynamics of systems in motion, and found that the hodograph of the light velocity referred to axes at the source of light, is an ellipsoid of rotation with the major axis parallel to the direction of translation, the light point being at one of the foci, and the eccentricity equal to an undetermined function of the absolute velocity. The present author now attempts to show that the basis of this principle, and on the recognition that the true uni-directional velocity of light cannot be measured, the transition from one moving system to others can be accomplished by a transformation analogous to that of Lorentz. Section 1 gives the basis of the Paschsky principle. Section 2 endeavours to express apparent in terms of true velocity. In section 3, the connections between various considerations derived from the investigation and the general theory of relativity and also the Einstein theory of gravitation are discussed. H. H. Ho.

1952. *On the Effective Continuity of the World; an Extension of Classical Dynamics.* **H. Tetrode.** (Zeits. f. Physik, 10. 5. pp. 317–328, 1922.)—The paper commences with a general discussion of electrodynamics. From it the author points out that there is no basis for the whole field being determined by means of a few places in it, and illustrates this view by other field conceptions such as are contained in Mie's theory of matter. The quanta phenomena appear in general, however, to be

not compatible with the latter field conception. The author has accordingly chosen another standpoint, and considers, as primary, the negative and positive electrons whose existence is experimentally verifiable. He assumes that every change of motion of an electron is conditioned by other electrons and regards the field as a mathematical construction which, in the limiting case where the quantum-like character of the phenomena may be neglected, is suitable for the representation of the reciprocal action between the electrons. On this basis with certain assumptions a theory is constructed in which no essential difference is found between thermal radiation and thermal conduction, and whereby absorption ensues in a definite atom or atomic complex. Light which has been emitted as a quantum is again absorbed as such, even if between times it has been subjected to great extension such as interference phenomena exhibit. The dynamics employed in the paper, like the classical, contains an undetermined force function. The author hopes that his theory will meet the various contradictions now obtaining between current theories. The paper is mathematical throughout. H. H. Ho.

1953. *A Noteworthy Case of Quantisation.* **P. Ehrenfest** and **G. Breit.** (Zeits. f. Physik, 9. 4. pp. 207–210, 1922. K. Akad. Amsterdam, Proc. 25. 1 and 2. pp. 2–5, 1922.)—Simple mechanical systems may be found in which the ordinary application of the quantum rule produces a quite definite but unacceptable basis for stationary motions. Bohr's correspondence principle affords an essentially new viewpoint for the treatment of these cases, and will possibly lead to a satisfactory solution of the difficulty. The present paper deals with an example of a rotating rigid electric dipole, chosen that it may be treated by quite elementary mathematics [see Abs. 1445 (1913)]. The difficulty which arises from the usual application of the quantum rule is shown, and the new standpoint offered by Bohr's correspondence principle demonstrated. The paper is mathematical throughout. H. H. Ho.

1954. *Gravitation and the Quantum Theory.* **A. H. Bucherer.** (Ann. d. Physik, 68. 1. pp. 1–10, July 20, 1922.)—According to this author the Einstein theory, notwithstanding its extension of fundamental physical conceptions, has not afforded an explanation of the real nature of gravitation, and does not connect gravitational force with other properties of matter. The author believes the quantum hypothesis to afford a basis for the explanation of this difficulty, and the present mathematical paper attempts to justify this conception. Section 1 deals with the general problem; section 2, discusses light deviation in the gravitational field; and section 3, considers the perihelion motion of mercury. The effect of the gravitational field upon free motion is found derivable from the fundamental hypothesis of the quantum theory that the energy of a light quantum is proportional to its frequency. H. H. Ho.

1955. *On the Quantelation of Disturbed Mechanical Systems.* **M. Born** and **W. Pauli, Jr.** (Zeits f. Physik, 10. 3. pp. 137–158, 1922.)—In only a few cases can the mechanical equations of motion be integrated by means of separation of variables and the quanta conditions then determined. Usually an approximation method has to be found; *e.g.*, the action of external force fields on atomic and molecular systems as in the Stark and Zeeman effects, the derivation of the ultra-red bands, and

the effect of thermal rotation and nuclear oscillation of molecules on the electronic orbits. Bohr and Kramer's method [Abs. 652 (1921)], which depends on orbital disturbance, is found to afford only a first approximation for the energy of disturbed systems, and the present authors now introduce a method which gives any degree of approximation, and is a generalization of Born and Brody's special treatment for a system of coupled resonators with feeble nonharmonic union [Abs. 248 (1922)]. Sections 1 and 2 discuss the undisturbed system in its various aspects. Section 3, deals with convergency and makes a comparison with the method of Epstein. It is found, according to this new method, that there is no principal but only a quantitative difference between the case of the Balmer lines in crossed electrical and magnetic fields and that of the helium lines. In both instances the spectral lines cannot be sharp, but in the latter case the indefiniteness is much less. The spectral lines remitted by disturbed mechanical systems may be calculated by means of an integration method in which those terms with very small numbers are deleted so that the series is rendered convergent. The author concludes that in general it is not possible by means of Delaunay's transformations to diminish appreciably the disturbance function. H. H. Ho.

1956. *Large Atmospheric Movements and Forecasting.* **P. Garrigou-Lagrange.** (Comptes Rendus, 174. pp. 1028–1031, April, 10, 1921.)—Certain general atmospheric movements of supposed lunar origin have been detected by the author from a study day by day of the conditions over as large an area of the globe as possible. The present note points out the application to forecasting in that the results referred to are of assistance in determining the future development of a given atmospheric situation, particularly as regards pressure and temperature. M. A. G.

1957. *On the Air Currents accompanying certain Barometrical Conditions according to Aerological Observations at Catania.* **F. Eredia.** (Accad. Lincei, Atti, 31. i. pp. 366–370, May 7, 1922.)—A former note contained an examination of the ascents of balloons carried out at Catania for nearly three years and reaching for the most part altitudes of nearly 4500 metres, which established the prevalence of winds of the fourth quadrant with the increase in altitude. The number of ascents to higher altitudes was somewhat limited; only 16 reached between 5500 and 7500 metres, all carried out at 9 o'clock. Some of them show southern currents of great constancy at the various altitudes, and if deductions as to the frequency of winds were to be made on the basis of these ascents the conclusions previously enunciated would have to be modified. The idea thus occurs that the ascents in question took place during the development of certain definite barometric conditions, wherefore it is well to direct our attention to the separate ascents with a view to ascertaining the concomitant variations of the air currents at the different altitudes, and since certain atmospheric disturbances apparently originate in the lowest strata we may arrive at a possible explanation of the influence of the mass of Mt. Etna. A detailed analysis of the meteorological conditions prevailing at the time of the various ascents leads to the conclusion that the Catania experiments show the conditions favourable to the formation of secondary depressions in northern regions, and as on the days in the vicinity of such special barometrical depressions the sky over those regions is generally cloudy

or misty, the importance is evident of pilot balloon ascents in southern regions where the greater clearness of the atmosphere permits of its being examined at high altitudes. —E. F.

1958. *Results of Actinometric Measurements carried out at Catania.* **G. Trovato.** (*Note I.* Accad. Lincei, Atti, 31. i. pp. 106–109, Feb. 5, and *Note II. Ibid.*, pp. 160–162, Feb. 19, 1922.)—*Note I.*—After referring to the conclusion arrived at by A. Bemporad that the coefficient of absorption increases progressively with the rising of the sun above the horizon, a conclusion completely in agreement with the theory of selective absorption, the author proceeds to describe the researches which he carried out in the low regions of the atmosphere at a small difference of level in August 1919 on consecutive days between the shore of Catania, almost at sea-level, and the R. Astrophysical Observatory with a difference of level of about 62 metres. He used an Arago actinometer (a couple of thermometers, of which one had a smoked bulb). Between the 10th and the 31st of August there were 15 days of observations in favourable conditions, 9 on the shore and 6 at the observatory, conveniently alternated. The actinometer was read every half-hour from 10 to 16 (mean time) and the psychrometer thrice daily : at 11, 13, 15. The values of the intensity of the solar radiation q observed at different hours of the day are proportional to the difference in temperature of the actinometer thermometers. The author also calculated for each series of observations the coefficients a, b, n of the formula proposed by A. Bemporad :

$$\log q = a - b\epsilon^n,$$

where ϵ is the atmospheric layer traversed by the rays. Comparing all the observed values of q and the respective values of q calculated for each day of observation, the author reaches the following conclusions :— (1) The maximum value of the intensity of the solar radiation on the various observation days does not, generally speaking, correspond to the maximum height of the sun, i.e. to the minimum value of the atmospheric layer ϵ traversed by the rays, but is about an hour in advance on the shore and correspondingly behindhand at the observatory. (2) The values of the intensity of the solar radiation found on the shore are always lower than those found at the observatory.

Note II.—In order to study the variation of the coefficient of absorption with the inclination of the rays, the author first of all calculated the values of q corresponding to the zenithal distances 30°, 40°, 60°, and 70° both for the morning and afternoon observations. He summarises the results of these observations as follows : (1) Both in the morning and in the afternoon the atmospheric layer of only 62 metres lying between the shore and the Catania R. Observatory exercises a powerful absorption on the calorific solar radiation. (2) The values of the coefficient of absorption corresponding to the afternoon observations are almost double those corresponding to the morning observations. (3) The coefficient of absorption increases with the increase in the zenithal distance of the rays. The diminution in the transparency of the air from morning to afternoon may be explained as being due to the evaporation of the sea water and to the strong absorptive power of the aqueous vapour for the calorific radiations. The conclusion that the coefficient of absorption increases with the zenithal

distance of the rays constitutes a result diametrically opposed to that found by A. Bemporad in elevated regions and attributed to the phenomenon of selective absorption of the solar radiation in the terrestrial atmosphere. The author thus concludes that the phenomena of selective absorption appear to be completely inverted by the antagonistic presence of other factors, among which the distribution of the aqueous vapour and of suspended matter certainly play a great part. E. F.

1959. *Is there a Cycle of Cosmic Phenomena?* **F. Nölke.** (Zeits. f. Physik, 10. 3. pp. 200–206, 1922.)—Since Kant first evolved the idea of a cosmic cycle various attempts have been made, and notably of late years by Arrhenius, Wiechert, and Nernst, to establish it on a scientific basis. The author examines the evidence for and against it, citing two preponderant facts which are hardly to be reconciled with such an assumption: (1) The continuous degradation of energy. (2) The continuous degradation of matter. The conclusion he arrives at is that it is a purely abstract intellectual conception, a hypothesis for which observed phenomena afford no support whatever, and that therefore, at the present stage of our knowledge the only admissible attitude for science may be summed up in the word "ignoramus." E. F.

1960. *Tidal Earth Tilting.* **R. Sekiguchi.** (Imp. Marine Obs. Kobe, Japan, Mem. 1. pp. 1–17, June, 1922.)—The tidal ranges of the ports along the western coast of Corea are very great, and that at Jinsen over 31 feet. Observations with Omori's horizontal pendulum for recording E.W. components were made to study the effects of the tidal load on the tilting of the earth. The investigation was confined to the M_2-tide. The mean semi-range of the E.W. component of the oscillation of the plumb line relative to the earth's crust was found to be 0″·0411, and the result of a theoretical treatment of the same quantity was 0″·0448. The discrepancy is small and may be due to the assumptions made in calculation. The results are preliminary to an extended study of the subject with special instruments. W. A. R.

1961. *Mean Relative and Absolute Parallaxes.* **K. Burns.** (Am. Phil. Soc., Proc. 60. 4. pp. 496–502, 1921.)—Instead of following the usual plan of resolving proper motions and radial velocities into components in the plane of the solar motion and perpendicular to it, the author finds it easier to consider the total motions, in order to compute mean parallaxes for stars of different spectral classes, and he compares his results with those derived from the motions perpendicular to the plane of solar motion (generally called the "tan" components). He compares the observed and computed parallaxes of stars brighter than 5·1 visual magnitude in order to find the mean parallax of the comparison stars, which comes out at 0″·010, but may be smaller. He notes that as the faint stars chosen for parallax determinations are only those of large proper motion they are of necessity those whose motion is almost entirely across the sun's way, so that they are not a fair sample of the average. He thinks an observatory devoting its parallax sessions to the subject could in a few years find the parallaxes of the representative stars of each of the magnitude groups 6·5 to 9·5 relative to the stars of 13th magnitude. W. W. B.

1962. *Parallaxes of Stars from Spectrum and Proper Motion.* **K. Lundmark** and **W. Luyten.** (Lick Observat., Bull. 19. No. 339. pp. 153–156, 1922.)—The first list contains parallaxes of 70 stars with large proper motion. The method employed is given in a previous paper [see Abs. 1861 (1922)]. From a MS. Catalogue of 730 stars with proper motion exceeding $0''\cdot50$ annually, a regression curve was derived from the known parallaxes of 350 of the stars. From this curve the absolute magnitudes of stars with known proper motion can be read off and their parallaxes found. The second list contains the parallaxes of 60 Class F stars similarly treated, and a comparison is given between some of the results and those obtained by other methods. W. W. B.

1963. *Errors of Meridian Observations.* **J. Trousset.** (Bull. Astronomique, 2. 1. pp. 45–54, 1922.)—The intention being to find not so much the total error as the values of the different contributions from various sources, the author makes a clear distinction between, for instance, the transit of a star over different wires on the same day, and its times of transit on different days. Adopting as units $\frac{1}{100}$ second of right ascension and $0''\cdot1$ in declination, he takes the cases separately. For right ascension he finds $\epsilon^2 = \epsilon_1^2/n + \epsilon_2^2/p + \epsilon_3^2 + \epsilon_4^2 + \epsilon_5^2$, n being the number of bisections, in p groups. Of the right-hand values he finds $\epsilon_1^2 = 11$, due to the observer, the atmosphere, and the chronograph; ϵ_2^2 (an error persisting for 10 or 20 seconds) $= 1\cdot4$, attributed to the same cause as ϵ_1; $\epsilon_3^2 = 1\cdot5$ in a period of about a quarter of an hour, due to atmosphere or clock; $\epsilon_4^2 = 1$, inaccuracy of computing; $\epsilon_5^2 = 1\cdot7$, due to constants. Thus when $p = 2$, $n = 9$, $\epsilon^2 = 6$, or if the constants are rigidly corrected, $\epsilon^2 = 4\cdot4$. In declination he obtains $\epsilon^2 = \epsilon_0^2 + \epsilon_1^2/n + \epsilon_2^2/p + \epsilon_3^2$, where $\epsilon_0^2 = 4$, error of circle reading; $\epsilon_1^2 = 6$, accidental error of a bisection; $\epsilon_2^2 = 3$, persisting for a few seconds, possibly due to variable refraction; ϵ_3^2 belongs to complex variations of atmosphere and $= 4$ for long series, but only $2\cdot5$ for observations at 4-minute intervals. In this case n is the number of microscopes (four) instead of wires. Thus $\epsilon^2 = 11$.

The observations being taken in a comparatively narrow zone of declination, and the values of the screws being known with great precision, the flexure and the principal part of the refraction are eliminated. The fundamental stars had a wider range of declination, and for these apparently $\epsilon^2 = 30$, which may be accounted for by their brightness and their greater range of refraction. W. W. B.

1964. *Comparison of Proper Motions.* **J. G. Porter.** (Astron. J. 34. pp. 58–60, May 9, 1922.)—Several lists of stellar proper motions derived from photographs have been published by the Royal Astronomical Society. Some of these are in Boss's Preliminary General Catalogue, and most of the remainder, when bright enough for inclusion in Astronomische Gesellschaft Catalogues, were observed at Cincinnati, and their proper motions derived from all meridian data obtainable. The author concludes from his comparison that the meridian observations give better results than the photographs, so that he deprecates the modern tendency to supersede meridian observations by photographic. W. W. B.

1965. *Blink Microscope for Study of Proper Motions of Stars in Astrographic Charts.* **J. Bosler.** (Bull. Astronomique, 2. 1. pp. 33–44, 1922.)—The astrographic programme has now been going on for more than a quarter of a century, and there are also about 150 photographs taken by the Brothers Henry rather earlier. Hence the material for determination of proper motion is very extensive, and it is time to set about this in the best and quickest way. After reviewing the several methods that have been suggested or adopted, many of them too laborious for general use, the author decides in favour of the blink microscope. He describes the principle of the instrument, with details of construction and adjustment, mentioning its use already at Potsdam, Mt. Wilson, Helsingfors, and Johannesburg.

By way of comparison he cites Le Morvan's work on a pair of plates taken at a 27-year interval. The result of this, which took several years to complete with the appliances then in use, was a list of 43 stars out of 1600, with sensible proper motions. Innes at Johannesburg sent for the plates, and returned them after five days, during which thirteen hours' work at the blink microscope produced 60 stars with sensible proper motion. To the two lists 18 stars are common, each omitting one star—not the same—found among the Greenwich proper motion stars.

To obtain further light on the question, the author examined the plates himself. He tabulates his results, giving also those of Innes and Le Morvan for the stars common to two or more of the lists. More motions were recognised after comparison with the earlier lists. He suggests various ways in which two observers may get different results, and recommends that all work should be done by at least two independent observers, and that attention should be restricted to undoubted motions, until at any rate the whole sky has been surveyed once.

W. W. B.

1966. *Personal Equation Varying with Declination.* **C. H. Hins.** (K. Akad. Amsterdam, Proc. 24. 4 and 5. pp. 168-176, 1922.)—After a preliminary discussion of the method of determining clock error and rate, and of the precautions to be observed in arranging a programme to minimise the errors of such determinations, the author tabulates for three different observers the personal equation depending on declination. Two of these agree in registering stars of high declination too early and of low declination too late, while the third seems to be unaffected by varying declinations. The author suggests that this result can be explained by the fact that the third observer adopts Gould's classical method of observing, while the other two follow Newcomb and try to "shoot the flying bird." He considers that the difference in the rate of apparent motion of stars at different declinations must affect the estimates of these two observers but not those of the third, and says this is an argument in favour of the adoption of an impersonal micrometer.

W. W. B.

1967. *Stellar Parallaxes Derived from Photographs.* **A. van Maanen.** (Astron. J. 34. pp. 55–56, May 9, 1922.)—This is a further list of about 50 stars and nebulæ, whose parallaxes have been determined with the 60-in. reflector at Mt. Wilson [see Abs. 1374 (1919)]. The largest values in this list are $0''\cdot118$ for P.G.C. 394 and $0''\cdot109$ for 17 Lyræ. The mean probable error of a parallax is given as $0''\cdot0057$. 17 Lyræ has a proper

motion of 1″·7, the largest in this list. There are eleven nebulæ, one variable, one spiral, and the rest planetary, in the list which also includes Nova Aquilæ. W. W. B.

1968. *Parallax of Coma Berenicis Cluster.* **K. Lundmark.** (Lick Observat., Bull. 10. No. 338. pp. 149–152, 1922.)—This cluster contains few stars, hardly more than the mean of similar surrounding areas, and may be a "moving cluster." By Russell's method from spectral class and absolute magnitude the author finds a parallax for the cluster of 0″·013. Five of the stars which have been measured give a mean parallax of 0″·012. Four of the stars are double, with observed orbital motion, giving by Jackson and Furner's method a hypothetical parallax of 0″·019, which suggests that the stars are more massive than they are assumed to be. A revised value is 0″·015. The author adopts 0″·012 as a mean value. The cluster appears to travel nearly in the same direction as Kapteyn's first star drift, and its convergent is close to that of the *Taurus* cluster. W. W. B.

1969. *Dark Nebulæ.* **H. N. Russell.** (Nat. Acad. Sci., Proc. 8. pp. 115–118, May, 1922. Nature, 110. pp. 81–83, July 15, 1922.)—Regions of obscuration are generally believed to be produced by huge obscuring clouds. In some cases these regions merge into faintly-luminous nebulosity near certain stars, and probably lie near those stars in space. The clouds are practically opaque. They are probably composed of dust particles, and the author discusses the probable size of the particles, and finds a relation between this and the obscuring power of the cloud. These dust particles will be strongly affected by radiation pressure, hardly at all by dwarf stars, but so strongly by giant stars, especially luminous ones of Class B, that only the coarser particles can come near such a star. The small particles are most effective in cloud formation, but as these are driven away from the neighbourhood of the star the luminous parts of the dark nebulæ do not brighten up close to the stars. The fine dust, being repelled, cannot be in true equilibrium among the stars, though some portions may be for a time in comparative equilibrium between opposing radiations.

The dark nebulæ may become luminous by reflecting the light of stars, as in the case of the Pleiades, or by excitation of the gaseous emission, as in the case of the Great Orion nebulæ, where the stars in the trapezium (Θ Orionis) appear to be the exciting agents.

It appears probable that the aspect of this nebula was different a million years ago, and that wisps and clouds of dust, drifting about, pass at times through the field of excitation of the trapezium stars, and when this happens the cloud or wisp becomes luminous, faintly near the outskirts and more brightly in the middle, where also nebular lines are seen. The absorbing clouds in Orion probably weaken the light of stars behind them by at least ten magnitudes, so that the great nebula may be regarded as a superficial fluorescence of the gaseous portion of a vast dark cloud, only visible near the exciting stars. W. W. B.

1970. *Orbits of the Two Components of Taylor's Comet,* 1916. I. **H. M. Jeffers.** (Lick Observat., Bull. 10. No. 334. pp. 120–130, 1922.)—The observations continue regularly, with intervals for full moon, from December 2, 1915, to April 8, 1916, after which only a few isolated

observations were obtained, including a late one by Barnard on May 27, 1916. Perturbations are included for 20-day intervals, caused by Venus, the Earth, Mars, Jupiter, and Saturn. Elements are obtained separately for the two components. They appear to have been closest together near perihelion, and there is no clear indication of the cause of their separation. No gravitational effect is shown between the components, just as none was found in the previous cases of Biela's Comet and of Brooks' 1889 V. The comet cannot be identified with Comet *e* 1909 (Daniel). The next perihelion passage about June 13, 1922, if the comet is then observed, should provide better values for mean daily motion, and, if both components are visible, for relative motion. W. W. B.

1971. *Further Study of Sodium Lines in Class B Stars.* **M[ary] L. Heger.** (Lick Observat., Bull. 10. No. 337. pp. 141–145, 1922.)—The stationary Ca lines in certain spectroscopic binaries have been noted since the first discovery in the case of δ Orionis [see Abs. 2470 (1904)]. Recently β Scorpii and δ Orionis were found to have Na lines also fixed. The D doublet had been observed in the present investigation of Class B stars, and in one case (o Persei) also the doublet at 3302 Å. Three classes of stars are considered: (1) binaries with stationary H and K; (2) with oscillating H and K; (3) non-binary stars.

In the first, represented by o Persei, the Na lines behave like the Ca lines. In the second, represented by π_4 Orionis, the Na lines oscillated in the same phase as the Ca lines, but were too hazy to determine the amplitude. In the third class three interesting stars were observed. In ζ Persei with a high space velocity the Na lines agreed better with the stellar motion than with a zero space velocity. In ρ Leonis the Na lines gave a velocity in agreement with the Ca lines, but 40 km. less than that of the other stellar lines. In γ Cassiopeiæ the Na displacement agrees with that of the narrow absorption line on the broad H emission.

On the whole the Na lines agree with the anomalous Ca lines.

W. W. B.

1972. *Spectra of certain Class B Stars in Regions* 5630 Å. *to* 6680 Å. *and* 3280 Å. *to* 3380 Å. **M[ary] L. Heger.** (Lick Observat., Bull. 10. No. 337. pp. 146–147, 1922.)—Plates used primarily for the D lines [see preceding Abs.] were examined for the visual region and for the ultra-violet. In the visual region 29 lines were measured, representing H, He, Na, N, Si, and perhaps a C spectrum similar to that in Wolf-Rayet stars. In the ultra-violet six lines were measured but none identified, though they suggest agreement with Wright's Nb lines. The plates being intended for the D lines, are not in such good definition for the ultra-violet. W. W. B.

1973. *Spectrum of γ Cassiopeiæ between* 5860 Å. *and* 6600 Å. **M[ary] L. Heger.** (Lick Observat., Bull. 10. No. 337. p. 148, 1922.)—This star shows both emission and absorption lines, so plates used for D lines [see Abs. No. 1971 (1922)] were also examined for this purpose, and the results are compared with those of Curtiss for the same star and of Merrill for ϕ Persei. Only two lines shown in ϕ Persei do not seem to occur in γ Cassiopeiæ, but the agreement with Curtiss is not very close, and it seems doubtful whether some of the lines are absorption or emission. W. W. B.

LIGHT.

1974. *Coefficient of Diffuse Reflection of Magnesium Oxide.* **F. Henning** and **W. Heuse.** (Zeits. f. Physik, 10. 2. pp. 111–128, 1922. Comm. from the Reichsanstalt.)—Recent work by Taylor [see Abs. 412 (1921)] tends to show that the value of the diffuse reflection coefficient of MgO is in the neighbourhood of 98 per cent. The authors have measured this coefficient by a new method. A cylinder is coated internally with MgO and is illuminated by the light from a fine Pt wire. A comparison of the brightness of the cylinder wall with that of the glowing wire gives a value of the reflection coefficient. The theory of the method is given in the paper. The value found is 95·5 per cent. $\pm$ 0·5 at a wave-length 0·647 μ. By direct measurement it was found that the partial reflection coefficient for an angle of emission θ was, for normally incident light $R\left(1 - 1{\cdot}3 \sin^4 \frac{\theta}{2}\right)$ where R is the value when $\theta = 0°$. The difference between the reflection coefficients found for red and green light was within the experimental error. J. W. T. W.

1975. *Light Absorption.* **G. Cario.** (Zeits. f. Physik, 10. 3. pp. 185–199, 1922. Extract of Dissertation, Göttingen.)—An investigation was made of the resonance spectrum (particularly the line λ2536·7) of mercury vapour in the presence of argon and a mixture of neon and helium. The results obtained show that with the neon-helium mixture the diameter of the excited mercury atom must be assumed at least three times larger and for the argon at least 5·5 times greater, in order to obtain a large enough decrease of intensity with increasing pressure of the gas. Similar results have been obtained by Füchtbauer and Joos [Abs. 1294 (1922)] for nitrogen and hydrogen. It seems probable that practically every impact of an atom with an excited mercury atom leads to a radiationless transfer. The latter part of the paper deals with energy transference at impacts, with particular reference to a mixture of thallium and mercury vapours, and of silver and mercury vapours. [See Abs. 701 (1921).] A. W.

1976. *A Chromophore Grouping of Atoms in Triple Salts and a General Theory of Colour.* **H. L. Wells.** (Am. J. Sci. 3. pp. 417–422, June, 1922.)—Attention is directed to the intense black colour and opacity of $Cs_4Ag_2Au^{III}_2Cl_{12}$, $Cs_4Au^{I}_2Au^{III}_2Cl_{12}$, and in a less degree of $Cs_4CuAu^{III}_2Cl_{12}$ in contrast with the pale colour and transparency of $Cs_4ZnAu^{III}_2Cl_{12}$, $Cs_4HgAu^{III}Cl_{12}$; and to the intense blue-black colour of $Cs_4Sb^{III}Sb^{V}Cl_{12}$ in contrast with the isomorphous $Cs_2Pb^{IV}Cl_6$. The presence in two of these intensely coloured salts of gold atoms of two valencies and of antimony of two valencies suggests that the cause of the colour may be the oscillation of electrons between similar atoms of variable valency, with the possibility that copper or silver may be coordinated in place of aurous gold with atoms of auric gold. The blackness of magnetite (ferroso-ferric oxide) and the deep colour of cuprcso-cupric solutions of copper chloride in hydrochloric acid are also referred to as supporting

the theory that colour in these inorganic compounds is due to electrons oscillating between atoms of variable valency. T. M. L.

1977. *Apparatus for Rapid Dissociation of Images by the Electric Spark in Cinematography.* **L. Bull.** (Comptes Rendus, 174. pp. 1059–1061, April 18, 1922.)—The employment of the electric spark for the cinematography of rapid movements [see Abs. 777 (1904)] has led to a considerable extension of the field of investigation of this method of analysis. The difficulty at present is not how to obtain sparks at sufficiently high frequency, but rather how to dissociate the images which they furnish upon the sensitive surface. The usual method is to have a film round a cylinder which is kept rotating as rapidly as possible. It is, however, not easy by this means to exceed a linear velocity of 100 m. per sec. Under these conditions with sparks succeeding each other at intervals of 1/50,000 sec. the images can only be 2 mm. in size. An apparatus has now been constructed by means of which larger images can be obtained. In this apparatus, which is described and illustrated diagrammatically, the dissociation of the images takes place in an inverse manner; the film remains at rest, and the train of images is first received upon a prism which totally reflects, and is in rapid rotation. The reflected images which are dissociated by this means are then received upon the sensitive film on the cylinder. The film forms a circle of 1 m. diam. around the prism and the objective. The optical axis of the objective is perpendicular to the plane of the circle, and the prism is oriented in such a way as to reflect at right angles upon the film the rays coming from the objective. Under the conditions described the images are dissociated upon the film with a velocity of 500 m. per sec. The only inconvenience of this method is that the images do not remain parallel among themselves from one extremity of the film to the other. A. E. G.

1978. *A Universal Photometer without Diffusing Screen.* **C. Fabry** and **H. Buisson.** (Rev. d'Optique, 1. pp. 1–12, Jan., 1922.)—The principle of the apparatus, the construction of which is illustrated and described in detail, is as follows. A small real image of the source to be measured, placed at a suitable distance, is projected on the eye of the observer, who thus sees a lens uniformly illuminated and forming one of the photometric surfaces. The second photometric surface is formed similarly by the light from a small comparison lamp. The two surfaces are brought into juxtaposition by means of a Lummer-Brodhun cube. Equality of brightness is obtained by interposing a wedge of absorbing material or suitable screens. The apparatus is contained in a small box, easily transported. The method has the advantage that any one of a number of sources (such as individual lamps in a room or a street) can be studied separately. In addition it eliminates the great loss in brightness inseparable from the use of diffusing screens. The apparatus can be applied to measure the brightness of a surface, and it has various special applications, notably the determination of the loss of light in optical instruments. J. S. D.

1979. *A New Method of Investigating Colour Blindness with a Description of 23 Cases.* **R. A. Houstoun.** (Roy. Soc. Edinburgh, Proc. 42. 1. pp. 75–88, 1921–1922.)—During the past four years surveys of the colour vision of more than 1400 students have been made at Glasgow.

The present paper describes a new method of investigating colour blindness based on Maxwell's colour diagram, and its application to the worst cases discovered by the above surveys. The results for each observer are represented by contour lines on the colour diagram; the ability of the observer to discriminate between any pair of colours is seen from his diagram at a glance, irrespective of the terminology of any particular theory. All the cases of colour blindness investigated were found to be trichromats in Maxwell's sense, not dichromats as stated in the textbooks. Also two observers who confused ordinary greens and reds were found on the whole to have quite as good a power of discriminating colour as the normal; their trouble was apparently due to their colour vision being extra sensitive to changes of wave-length in the green part of the spectrum and not sensitive enough to changes of wave-length in the yellow.

AUTHOR.

1980. *Critical Frequency Relations in Scotopic Vision,* **H. E. Ives.** (Optical Soc. America, J. 6. pp. 254–268, May, 1922.)—It has previously been noted that the relation of critical frequency to illumination undergoes an abrupt change at about 0·25 metre-candles. At this point there is apparently a change from "Cone" to "Rod" vision. The change is very marked for blue light. The present study deals essentially with rod vision. Low intensity light from a mercury lamp, with a blue filter, was projected through a slit whose sides are radial to an axis about which 3 discs rotate. By varying the contour of the discs any desired variation in brightness could be obtained, and a wide variety of combinations of shape, amplitude, and opening was provided. The relation between critical frequency and illumination was then studied, and diagrams are presented showing the nature of the results. The chief conclusions are as follows:—(1) At low intensities with blue light critical speed of disappearance of flicker becomes independent of the intensity, but different for each wave-form of stimulus, and (2) the relationship between critical speed and wave-form is approximately represented by the equation $\omega = c \log 2W/\delta$, where W is the coefficient of the first periodic term of the Fourier expansion representing the wave form, divided by the mean value; ω is the critical speed, c is a scale constant, and δ is a small number of the order of a few hundredths. J. S. D.

1981. *The Optics of Hydrogen and the Bohr-Debye Model.* **R. Gans.** (Zeits. f. Physik, 9. 1 and 2. pp. 81–91, 1922.)—Calculations of the refraction, the dispersion, the Tyndall effect, and the double refraction of hydrogen based upon the Bohr-Debye model. The calculations are carried further than had been done by Debye and by Sommerfeld. It is found that the results are in better agreement with the theory than Kirn [see Abs. 1413 (1921)] assumed after his own experiments. As regards the double refraction, experimental verification appears almost impossible. H. B.

1982. *Invariant Relations in Glass Dispersion.* **P. G. Nutting.** (Optical Soc. of America, J. 6. pp. 109–111, March, 1922.)—Shows that Wright's dispersion formulæ, viz., $n_1 - n_2 = c(n_3 - n_4) + k$, where c and k are constants [see Abs. 303 (1922)] indicates that the relation between n and λ has the form $n = af(\lambda) + b + F(\lambda)$, where $f(\lambda)$ and $F(\lambda)$ are unlimited, except that they must involve only numerical constants.

In the special cases where $k = 0$, the formula becomes $n = af(\lambda) + b$ which suits the Cauchy formula. The author therefore concludes that while the dispersion formulæ have a practical utility, they do not indicate any specific form of $f(\lambda)$. J. W. T. W.

1983. *Photography of Moving Interference Fringes.* **A. Trowbridge.** (Optical Soc. of America, J. 6. pp. 195–198, March, 1922.)—The vertical straight-line fringes formed by a Michelson interferometer were used in taking the photographs here reproduced. A real image of these fringes was formed by a small achromatic camera lens ($f = 4{\cdot}5$). About one inch in front of the real image formed by this lens was placed a cylindrical lens of about one inch focus with its axis horizontal. The converging beam formed by the spherical lens just completely filled the vertical aperture of the cylindrical lens. The action of the cylindrical lens was practically to leave unchanged the horizontal spacing of the fringes, but to reduce the vertical line images to a series of point images of enhanced brilliancy. At the focus of the cylindrical lens, a narrow strip of sensitised paper could be made to pass in a vertical plane by a simple roller mechanism which fed the paper from a roll into a bath of developer enclosed in a light-tight box. In fact the supply of paper, the developer, and the rollers were all in the same light-tight enclosure which carried the cylindrical lens. As the developed record came out of the bath it could be drawn out into the not too brightly lighted room and fixed without fogging. Automatic development is quite possible in the case of fringes formed by blue and violet lines, but in the case of faint lines, or strong lines in the green or yellowish green, hand development is better. With stationary fringes a series of lines parallel to the edges of the moving strip of paper is obtained. With the fringes in motion the record looks like an inclined fringe system, the inclination of which is determined by the relative velocities of the paper and the moving fringe system. The number of fringes which pass a given point may be counted rapidly by counting the number which move out of the field of view at the edge of the record. Typical records are shown, in two of which periodical changes in visibility are evident, this being due to the presence of more than one line in the light source. A. W.

1984. *Explanation of some Interference Curves of Uniaxial and Biaxial Crystals by Superposition of Elliptic Pencils.* **J. W. N. Le Heux.** (K. Akad. Amsterdam, Proc. 24. 4 and 5. pp. 195–197, 1922.)—The interference-curves of some crystals may be regarded as the "moiré"-images of two concentric elliptic pencils, each containing the curves of intersection of the two parts of the successive wave-surfaces with the upper side of the crystal plate. These wave-surfaces are supposed to be homothetic, and so the velocities in directions normal to the wave fronts are uniform. Experimental results with pendulums arranged to trace curves (as in a harmonograph) show that this supposition will explain the phenomena in a polarisation microscope, at any rate at some little distance from the centre. Further experiments gave the black cross in the centre with fair accuracy. A. W.

1985. *Natural Optical Activity of Crystals.* **M. Born.** (Zeits. f. Physik, 8. 6. pp. 390–417, 1922.)—Explanations of the optical activity of liquids and crystals on the electron theory were outlined in 1915,

both by Oseen and by the author. In the present paper the author carries the matter further, referring to his Dynamik der Kristallgitter and Thermodynamik der Kristallgitter [see Abs. 1077 (1922)], also as to his symbols. The paper is mathematical throughout. He finds that the lattice theory can account for the propagation of light through optically-active crystals on the simplest assumption of central atomic forces without any new hypotheses. But he disregards absorption, since there is so far no rational theory of the energy dissipation in crystals. A numerical calculation of the gyration parameters from the lattice structure would be very desirable. For this purpose we should know the elementary potentials, depending upon two quantities, the one due to interatomic effects, the other to electromagnetic radiations from other atoms of the lattice. The latter is determinable by the method of P. P. Ewald and the author. Ewald has made the calculation for certain lattices of rhombic symmetry, and has deduced double refraction purely from the structure, substituting isotropic quasi-electric linkages for the interatomic forces. Similarly the refraction might be calculated, and this appears, in the case of sodium chlorate and bromate, more promising than the calculation of the double refraction, because the latter need not be determined by the lattice structure. In an irregular lattice the bricks, the atoms or molecules, might themselves be anisotropic, and might contribute to the double refraction. Regular active crystals are isotropic, and the substances lose the power of rotation completely when they are dissolved; in that case activity is purely a property of the lattice. H. B.

1986. *Experimental Proof of some Theories concerning the Natural Rotation Capacity of Optically Active Solutions.* **P. Wetterfors.** (Zeits. f. Physik, 8. 4. pp. 229–242, 1922.)—The Drude theory of rotation of plane of polarisation states that the specific rotation is independent of the solution concentration as well as of the nature of the solvent, but this is contradicted by experience, since the specific rotations of all active substances appear to depend on the above factors, which latter also enter into the expressions afforded by the Lorentz-Livens theory [see Abs. 1058 (1914)]. This theory, however, like Drude's, cannot explain why the rotation is connected with the asymmetry of the molecule, a problem which has been investigated by Born, Oseen, Gray, and Landé. The conclusions obtained by the latter authors agree in that molecules are regarded as having unsymmetrically arranged resonators, which are coupled either by electrostatic or other conservative forces. The distance between mutually coupled particles is regarded as small, and may not be neglected in relation to the wave-length of the incident light. The resonators act upon each other in unequal oscillation phases. Oseen has derived a quantitative expression for the rotation of liquid mixtures, viz. $[\Omega]: (n^2 + 2)^2 = \text{const}$, where $[\Omega]$ is the specific rotation and n the refractive index of the solution. It is assumed that no part of the active molecules in the liquid unite with each other or with inactive molecules to form greater complexes. Previous experimental work to establish the theory has been carried out only with sodium light, reference being made to work by Golse and Peacock, and the present author now describes an extension of the experimental observations for other wave-lengths. For this purpose the active substances camphor and α-mono brom camphor were employed, and for solvents acetone, benzol, toluol, ethyl alcohol, and propyl alcohol were chosen. The experimental arrangements are

described for a Lippich half-shade polarimeter, and tables of measurements are included. It is found that the rotation Ω generally increases with temperature, and, since the concentration of a solution decreases with temperature, therefore the specific rotation is greater, Brom camphor in acetone solution provides an exception, the rotation Ω decreasing with rising temperature. The results are discussed with respect to the theories of Lorentz-Livens and Oseen, and a discrepancy found between theory and experiment. Lundblad's work is quoted in conclusion, since he found the theory of Oseen to be too inelastic and not to account sufficiently for the influence of the surrounding medium on the active molecules. Lundblad showed also that the effect of the resonator oscillations of the surrounding molecules is dependent on the shape of the effective molecular surface, and in this he opines a possible cause for the deviations.

H. H. Ho.

1987. *Grandjean's Anisotropic Liquids* (*Liquid Crystals*) *with Equidistant Planes.* **G. Friedel** and **L. Royer.** (Comptes Rendus, 174. pp. 1523–1526, June 12, and pp. 1607–1610, June 19, 1922.)—(1) The structure discovered by Grandjean appears to characterise many other doubly-refracting liquids which exhibit "epipolic" colours and great rotatory power, *e.g.*, the cinnamate, cinnamylate, and caprylate of cholesterol, and many mixtures of its salts. These liquids do not always exhibit this phenomenon, but when they do the rotatory powers are enormous, several scores of revolutions per millimetre; at the same time they exhibit spectral colours, which depend on the equidistance of the planes, and vary very greatly with temperature, the reflected light under some conditions passing, however, into the ultra-violet or infra-red. The reflection of light affects only one of the circularly polarised components, but the ray is reflected *without change of sign*, so that the reflected and transmitted beams can be rendered colourless by the same circular analyser, dextro for cholesteryl cinnamylate, and laevo for amyl cyano-benzylidene-aminocinnamate. Freshly-prepared specimens of the anisotropic liquid usually have a confused structure, and the equidistant planes are developed most readily by agitating the cover-slip; if this is not done the liquid retains its confused structure, and, in the absence of the planes, neither the colours nor the rotatory power are observed.

Stumpf has shown that the rotatory power is reversed on either side of the wave-length of the reflected light. At this critical wave-length the dextro ray is completely reflected, in the case of the amyl ester cited above, and the rotatory power disappears; the rotatory power increases asymptotically, however, as this wave-length is increased, being dextro on the violet side and laevo on the red side of the critical wave-length. Towards the deep red it diminishes progressively, but on the side of the violet it diminishes to a minimum, and then slowly increases.

The rotatory power of these liquids is regarded as analogous to that which is observed when an isotropic liquid, such as azoxyphenetol or azoxyanisol, is twisted into spirals; its enormous magnitude is attributed to a spontaneous torsion of the liquid in the minute intervals between the equidistant planes.

(2) A mixture of the amyl ester (2·5 to 2·75 parts) with cholesteryl benzoate (1 part) exhibits at temperatures near the freezing-point the structure of the former type, but at temperatures near the melting-point the structure of the latter type of anisotropic liquid. In both conditions

the wave-length of the reflected light is in the infra-red, and the planes are wider than in the pure amyl ester. One passing from one condition to the other, however, the rotatory power changes sign : in the lower ranges of temperature it is positive, but in the higher ranges it is negative ; in each condition it decreases from violet to red. As the transition-temperature between the two conditions is approached the equidistant planes separate more and more widely ; they can still be seen when they are separated to 3 or 4 times their original distance, but they disappear completely at the transition-temperature. If the sample is observed between a plane surface and a convex cover the rings which show the rotatory power weaken, and then disappear completely at the transition-point. The edges of the equidistant planes become more and more like the " threads " which are characteristic of inactive anisotropic liquids of the type of azoxyphenetol, and which are known to be the axes round which the structure is curled ; but the structure is never normal to the optic axis. The conclusion is drawn that the torsion between the planes which is the cause of the rotatory power, disappears with the planes at the transition temperature, but is reversed in sign by passing through it.

Further, the wave-length of the reflected light, which determines the rotatory power must vary with its inclination to the planes. The change of colour on tilting the specimen is well known ; the wave-length of the inversion of rotatory power can be observed with the help of a monochrometer, and has now been observed to change in the same way as the colour of the reflected light, although this has not been tested in a strictly quantitative manner. T. M. L.

1988. *Fluorescence, Photochemical Effect and Einstein's Law.* **F. Weigert.** (Zeits. f. Physik, 10. 5. pp. 349–351, 1922.)—According to Perrin the intensity of fluorescence of organic solutions goes together with their sensitiveness to light, and fluorescence is a secondary phenomenon connected with the transformed molecules [Abs. 1214 (1919)]. Wood agrees, and concludes further [Abs. 1613 (1922)] that illumination by equal quantities of light, but at greater radiation density, has stronger effects. Pringsheim (*ibid.*, 10. p. 176) doubts the similarity between fluorescence and photochemical action. The author objects that fluorescein is bleached only in the presence of oxygen, but its fluorescence is independent of oxygen. Yet the velocity of photochemical reaction decreases (instead of increasing) with the partial oxygen pressure ; quinine sulphate takes up oxygen 30 times more rapidly from a 0·6 per cent. mixture of oxygen with nitrogen than from pure oxygen. That is in agreement with the observation of Wood and of Pringsheim that the colour changes are more rapid in the concentrated light cone of a lens than with parallel illumination ; in the former case the solution is more rapidly impoverished in oxygen. The real nature of the processes is still obscure, and the systems of colouring matters are too complex for investigating the elementary photochemical reactions and for testing the law of Einstein. H. B.

1989. *Dispersion of Light in Fluorescent Solutions.* **A. Carrelli.** (Accad. Lincei, Atti, 31. i. pp. 157–160, Feb. 19, 1922.)—With fluorescent substances exhibiting pronounced absorption and intense fluorescence, it appears possible that there exist two distinct types of vibrators, and

hence two corresponding anomalies in the refractive index, one referring to the zone of emission and the other to that of absorption. By means of the Jamin refractometer aqueous solutions of various substances of the triphenylmethane group have been investigated, the iridescent fringes obtained with a powerful source of light being analysed spectroscopically. The results obtained indicate that, in fluorescent substances, the presence of emitting vibrators modifies the dispersion curve in a manner similar to that observed with absorbent vibrators. The various substances examined differ as regards the magnitude and distribution of this effect. T. H. P.

1990. *On the Destruction of the Fluorescent Property in Fluorescing Solutions by Light and the Photo-chemical Equivalent Law.* **P. Pringsheim.** (Zeits. f. Physik, 10. 3. pp. 176–184, 1922.)—Perrin has recently described experiments [Abs. 1214 (1919)] in which small drops of alcoholic and aqueous solutions of such substances as fluoreceine, eosine, etc., observed under the microscope show strong fluorescence when illuminated with exceedingly powerful concentrated light from an arc lamp, but speedily (sometimes within a few secs.) and completely lose their ability to fluoresce. The present author has repeated these experiments under different conditions, and arrived at similar results. In accord with both Perrin and Wood [Abs. 1989 (1921)], the author finds the destructive effect to depend on the light concentration. With two solutions of equal concentration the one which exhibits weaker fluorescence is more rapidly altered than the other. With two solutions showing equally bright fluorescence and possessing identical absorption and fluorescence spectra, one may generally be more rapidly changed than the other, thereby showing the production of a further transition product. The fluorescence spectrum of such a newly formed body is displaced in the same sense as its absorption spectrum. At low temperatures the intensity of fluorescence is not appreciably changed, the chemical reaction being almost entirely inhibited. From these results the author concludes that the Perrin hypothesis, according to which fluorescence is an attendant effect of chemical transformation, is untenable. On the other hand, there is the twofold possibility:—either fluorescence or chemical transformation is of consequence for the validity of the photo-chemical equivalent law. Experimental details and results are discussed very fully. H. H. Ho.

1991. *Fluorescence of Mercury Vapour Excited by Röntgen Rays.* **J. S. van der Lingen.** (Zeits. f. Physik, 10. 1. pp. 38–40, 1922.)—The object of the experiments described was to find out whether the spectrum of the fluorescence excited in mercury vapour by Röntgen rays was the same as that for fluorescence due to ultra-violet light between the wave-lengths λ1860 and λ2550 Å., and also to decide whether the hardness of the Röntgen rays had any effect on the nature of the emission spectrum. Considerable differences were found between the fluorescence spectra excited by Röntgen rays and by ultra-violet light from a cadmium spark. The fluorescence spectrum for vapour of small density excited by soft Röntgen rays (such as are absorbed by a glass plate 1 mm. thick) consists of two structureless bands and five emission lines. The bands extend from λ4350 to λ5500 and from λ3100 to λ3600, the maxima being at λ4350 and at λ3300. The emission lines are $\lambda\lambda$3140, 3660, 4050, 4350,

and 5500. The lines λ4050 and λ4350 are strong and bright, and only disappear when the vapour density increases. The other three emission lines are faint. With harder rays and low vapour density the lines λ4050 and λ4350 are excited, as well as the band above λ4350. The ultra-violet band is, however, very weak. With higher vapour densities the above lines disappear. No trace could be found of the lines λ2536, λ2346 given by Steubing [Abs. 79 (1910)]. [See Abs. 134 (1922).]

A. W.

1992. *Arc Spectrum of Yttrium.* **L. F. Yntema** and **B. S. Hopkins.** (Optical Soc. of America, J. 6. pp. 121–134, March, 1922.)—The yttrium examined was a portion of that prepared at the University of Illinois for the determination of the atomic weight value recently accepted by the International Committee on Atomic Weights. A Hilger quartz spectrograph was employed, and the yttrium oxide was used in an arc with copper electrodes. The iron spectrum was employed as reference. A complete list is given of the wave-lengths determined, from λ2243 to λ4200. Eder's values are included for comparison. A. W.

1993. *Structure of the Second Cyanogen Band.* **J. Ôkubo.** (Tôhoku Univ., Sci. Reports, 11. pp. 55–86, April, 1922.)—Photographs were obtained of the second cyanogen band in the second and third orders of a Rowland concave grating with a radius of curvature of 21·5 ft. and a ruled surface of 5·1 × 3·3 inches. The number of lines per inch was 15,000. Special precautions were taken to eliminate as far as possible all impurities from the carbons used in the arc employed as the source of light. Wave-length tables are given of about 1555 lines of the second cyanogen band, the wave-lengths ranging from λ4216 Å., the first head of the band, to λ3900 Å. The band was found to contain many doublet lines whose components lie close together, some of these having been described as singlets by previous investigators. Three remarkable series were found, the first, a triplet series, beginning at the first head of the band, and the other two, which are close doublets, beginning at the second head. The intensity distribution of these three series is described. Certain simple relations were also found between the differences in the ratios of the wave-numbers of the band heads. [See Abs. 1356 (1917).]

A. W.

1994. *Excitation of Gas Spectra by Chemical Reactions.* **F. Haber** and **W. Zisch.** (Zeits. f. Physik, 9. 5. pp. 302–326, 1922.)—A continuation of the work of Haber and Just [Abs. 1733 (1911)]. The inner cone (of stationary explosions) of the Bunsen flame is colder (1500° to 1600° C.) than the outer cone (1800°); yet the inner cone shows greater luminosity and greater electric conductivity. Both these properties may hence partly be due to chemical reactions. When NaCl or LiCl are introduced into the flame, the cone can, moreover, with certain arrangments, be seen as a bright pointed arch. The authors investigate cold flames produced by burning sodium vapour in vapours of Cl, Br, I, O, keeping the reaction temperature low by diluting the gases with nitrogen. A bright cone is seen at the mouth of the tube through which the Na and N are discharged, and the D lines can be distinguished. The D radiation can only be due to sodium atoms in the uncombined state, they consider; for the chemical

reaction of sodium is characterised by a change in the quantum orbits of its valency electron. If the radiating atom then be different from the reacting particles, the assumption that the reacting particles radiate the energy which became available by the reaction, must be abandoned, and we have to suppose an intermediate process which passes this energy on to unchanged atoms. This intermediate process must consist of collisions. A new theory is therefore proposed for processes in which the chemical reaction is accompanied by a light emission which exceeds the black radiation at that temperature. That thermal luminescence can be called forth by collision would be in accordance with Bohr and with Franck's experiments and conclusions. Since there would probably be both primary particles and final particles of $NaCl_2$, as well as of NaCl, the authors conduct further similar experiments with mercury vapour and chlorine gas ; the mercury vapour consisting of atoms, the chlorine vapour of molecules, both the primary and the final particles would be $HgCl_2$. In other experiments potassium vapour and oxygen are made to interact in an electric field, when considerable conductivity is observed. The paper also describes a redetermination of the vapour pressure of sodium by the method of Wartenberg. The results are in agreement with those found by Ladenburg and Minkowski and others. H. B.

1995. *Spectroheliographic Investigation of the Electric Arc.* **R. G. Berthold.** (Phys. Zeits. 23. pp. 178–184, April 15, 1922.)—In contrast to the results of Lenard and Kramsztyk [Abs. 67 (1916)] it was found that whatever the arc length, current strength, or salt concentration the line λ4752 belonging to the second subordinate series of sodium was always found further to the outside in the arc than the line λ4983 belonging to the first subordinate series. By comparison of these and other monochromatic arc images a modification of Oldenberg's [Abs. 451 (1914)] spectroheliograph was arrived at which permitted monochromatic arc images for different wave-lengths to be observed simultaneously. With this apparatus different types of principal and subordinate series and bands were investigated, the metals concerned being chiefly sodium and calcium. A. W.

1996. *Röntgen Spectrum Oscillograph.* **G. Jaeckel.** (Zeits. f. Physik, 9. 5. pp. 300–301, 1922.)—The author and Seemann have modified the Röntgen spectrograph of Seemann, which measures the maximum potential applied to a bulb, into an oscillograph for drawing potential curves. A photographic film is wrapped round a drum, which is turned by a variator running synchronously with the alternating generator feeding the bulb ; the axis of rotation is at right angles to the lines of the spectrum. Various applications, also for the study of glow discharges, are mentioned in this preliminary communication. H. B.

λ18
P

HEAT.

1997. *A Method for the Determination of Thermal Conductivities at Temperatures of Incandescence.* **M. v. Laue** and **W. Gordon.** (Preuss. Akad. Wiss. Berlin, Ber. 13. pp. 112–117, 1922.)—The method developed depends on the temperature fluctuations which are shown by an incandescent filament when heated with an alternating current. The mathematical theory which is given makes certain assumptions, some of which possibly are never quite fulfilled in practice, but which can be realised to a great extent by suitable experimental conditions. The increase in electrical and thermal conductivities with a local increase in temperature for example is neglected, and the energy radiated per unit surface area is given as a function of the surface temperature T in the form A + BT. The development of heat is assumed to be sinusoidal, though a generalisation of the theory to other stream curves offers no difficulty. The frequency is assumed to be so small that the current is uniformly distributed over the cross-section of the wire, so that the heat produced per unit volume and per unit of time can be put as $q(1 + \cos \nu t)$, where q is a constant. Starting with the differential equation of the thermal conductivity λ, $\lambda(\partial^2 u/\partial r^2 + 1/r \,.\, \partial u/\partial r) - c\rho \partial u/\partial t = -q(1 + e^{i\nu t})$ equations are obtained with the use of Bessel functions from which λ can be calculated with the assumptions given. T. B.

1998. *Vaporisation in Steps as Related to Surface Formation.* **W. D. Harkins** and **L. E. Roberts.** (Am. Chem. Soc., J. 44. pp. 653–670, April, 1922.)—The amounts of energy involved in the various steps in the process of vaporisation of a number of liquids have been calculated on the assumption that the surface through which the vaporisation occurs is not highly curved. In the case of non-associated liquids with symmetrical molecules, the molecular values for the latent heat of surface formation, the total surface energy, the energy of thermal emission, and the internal heat of vaporisation at definite corresponding temperatures are nearly proportional to the critical temperatures of the liquids, and the same appears to be the case with the free surface energy if the range of temperature is not too great. The effect of a lack of symmetry in the molecule, especially if marked, is to lower the molecular free surface energy, latent heat of surface formation, and total surface energy, and to increase the energy of thermal emission.

According to Stefan's law, the ratio of the total energy necessary to carry a molecule from the interior of a liquid into the surface to its total heat or energy of vaporisation is equal to 0·5. The results now obtained show, however, that the value of this ratio increases as the symmetry of the molecule increases and as the corresponding temperature rises, and appears to approach unity as the corresponding temperature approaches unity. [See Abs. 1162 (1921).] T. H. P.

1999. *On the Calculation of the Molecular Quadrupole Moments from the Equation of State.* **W. H. Keesom.** (K. Akad. Amsterdam, Proc. 24. 4 and 5. pp. 162–167, 1922. Phys. Zeits. 25. pp. 225–228, June 1, 1922.)—When the potential in the field of the electric charges in a rotational

symmetric homopolar molecule is developed in a series of powers of r^{-1}, the first term may be regarded as being due to a zonal quadrupole. So far as is evident from the investigation of the equation of state, especially for hydrogen, the molecular attraction in diatomic homopolar gases may be regarded to a first approximation as due to such a quadrupolar term in the field of force of the molecule, at least for a high temperature and in a diluted gaseous state. That finally an attraction results must be ascribed to two causes: (1) That two molecules when approaching each other will try to direct each other in such a way that attracting forces arise between them; (2) that in two approaching molecules the charges are displaced by their mutual influence so that this gives rise to an attraction. As far as this Debye [Abs. 279 (1922)] and the author [see Abs. 158 (1922)] agree. Their opinions differ, however, on the magnitudes of the quadrupole moments to be ascribed to the molecules of the gases in question (hydrogen, oxygen, and nitrogen) on account of the data of the equation of state. The author has deduced these quadrupole moments from the experimentally found second virial coefficients for the above gases at selected temperatures, by comparing them with the dependency of the second virial coefficient on the temperature as deduced for fixed quadrupoles and thus without attending to the displacement of the charges mentioned in (2) above. Afterwards he has proved that at those temperatures the influence of the displacibility of the charges is only small compared with that of the attraction due to the fixed quadrupoles. From this it is evident that the values for the quadrupole moments derived from the experimental data do not undergo considerable changes by the displacibility of the charges. Following another way of calculation, however, Debye finds considerably higher values for the quadrupole moments, and on several grounds he prefers these higher values. The author now shows that he cannot subscribe to this opinion, and by further calculation investigates the influence of the polarisability of the molecules on the value found for the quadrupole moment. This he finds to be small. Debye's opinion that the polarisation of molecules, caused by their mutual influence, is of great importance was based on the values of the coefficients of the mean reduced equation of state. Onnes, who developed the latter, declared emphatically that for no substance will it coincide with the real reduced equation of state: which would only be the case for substances which obeyed rigidly the law of corresponding states, a circumstance not true for hydrogen as compared with nitrogen and oxygen. The author shows the impracticability of the mean reduced equation of state, while the special equation of state deduced from measurements by Onnes and Braak also gives too high a value for the quadrupole moment when Debye's method of calculation is used. Accordingly, the author proceeds as in previous communications. A section is devoted to the further development of the second virial coefficient for spherical polarisable quadrupole molecules, and the results when applied to hydrogen, show justification for the author's conclusions as given above. H. H. Ho.

SOUND.

2000. *Some Indian Stringed Instruments.* **C. V. Raman.** (Indian Assoc. for Cultivation of Science, Proc. 7. Parts 1 and 2. pp. 29–33, 1921.)—The present paper deals with the remarkable acoustic properties of the "tanpura" and the "vina," which are two of the most highly reputed among Indian stringed instruments. The form of bridge used in these instruments is quite different from that usually found in European stringed instruments. In the tanpura the string passes over the wooden upper surface of the bridge, which is curved to a special shape so that, by insertion of a thread of wool or silk, a finely adjustable grazing contact of string and bridge is secured. In the vina the upper surface of the bridge is of curved metal, and the string leaves it at a tangent. The tones of these instruments show a remarkable, powerful series of overtones, which gives them a bright and pleasing quality. Experiment with these instruments shows that the validity of the Young-Helmholtz law (according to which particles having a node at the plucked point should not be excited) is completely set aside. A possible mechanical explanation of this result is suggested. [See Abs. 321 (1919).]

E. H. B.

2001. *Sound of Aeroplanes.* **C. Dévé.** (Comptes Rendus, 174. pp. 1010–1012, April 10, 1922.)—When, standing upright on a hard surface, fairly smooth, one hears an aeroplane passing overhead, a roar of low pitch is heard destitute of high partials. If one lowers the head the pitch rises; on placing the ear within about 20 cm. of the ground, the pitch appears to rise more than two octaves. The impression of rise of pitch ceases when the aeroplane is about 45° from the zenith. The phenomenon is never perceived by an observer at a window of an upper floor. The phenomena are discussed and an explanation attempted. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROMAGNETICS, AND ATMOSPHERIC ELECTRICITY.

2002. *Capacity of Two Infinitely Thin Plates.* **R. Serini.** (Accad. Lincei, Atti. 31. i. pp. 182–184, March 5, 1922.)—A mathematical investigation of the capacity of two very thin plates which the author shows to be expressible in the form $a/\pi + \beta/l$ where a is the radius of the plates and l the separation. β is a constant which may be determined experimentally. J. W. T. W.

2003. *Electromagnetic Mass and the Theory of Relativity: Inertia of Electricity.* **E. Fermi.** (Accad. Lincei, Atti, 31. i. pp. 184–187, March 5, and pp. 306–309, April 23, 1922.)—On the electromagnetic theory the mass of a system of electric charges which is rigid in the sense of the classical mechanics is $\frac{4}{3}\,u/c^2$ where u is the electrostatic energy of the system and c is the velocity of light, the velocity of the system being small compared with c. On the theory of relativity the mass of a system of energy u is u/c^2. This discrepancy the author shows to have originated in a conception of a rigid body which is contrary to the theory of relativity. When this conception is corrected in accordance with relativity theory both methods lead to the same value, viz. u/c^2. J. W. T. W.

2004. *Slow and Quasi-Stationary Motion of a Rigid System of Electric Charges.* **E. Persico.** (N. Cimento, 23. pp. 239–246, Feb.–March–April, 1922.)—Mathematical.

2005. *Apparent Subelectrons by Charges on Ultramicroscopic Particles.* **R. Bär.** (Ann. d. Physik, 67. 3. pp. 157–200, May 17, 1922.)—In discussing the conclusions drawn from experiments on the charges of small particles by Ehrenhaft and his school on the one side and all other workers on the other side, it is here shown that the conflicting results of Ehrenhaft and Parankiewicz are completely explained through their neglect to take the Brownian motion into consideration. It is here stated that there is not the slightest evidence of the presence of quantities of electricity less than the electronic charge. The apparent subelectron supposed found by Ehrenhaft and his school was due to the assumption of a too-great density [see Abs. 282 (1911)]. E. H. B.

2006. *Photoelectric Effect of Ultramicroscopic Particles.* **R. Bär** and **Y[u] C[hen] Yang.** (Arch. des Sciences, 4. pp. 249–252, May–June, 1922. Paper read before the Soc. Suisse de Physique, May–June, 1922.)—Particles of radius (2 to 14) $\times 10^{-5}$ cm. obtained by evaporating selenium in dry air were maintained in suspension in a Millikan condenser and subjected to the ultra-violet rays from a mercury arc. Using Einstein's equation,

$$h(\nu - \nu_o) = \tfrac{1}{2}mv^2,$$

as applied to the experiments, it was found that they gave a new proof of the non-existence of subelectrons. E. H. B.

2007. *Velocity of Propagation of Electromagnetic Waves.* **U. Doi.** (Phys. Math. Soc., Japan, Proc. 4. pp. 71–85, April–May, 1922.)—The author deduces the Lorentz formula for the dispersion of a refracting medium and the complete Lorentz expression for drag due to motion of the medium. In the case of a source in motion, the resultant velocity of the train of electromagnetic waves is shown to be $\pm c - v$, where the symbols have the customary significance. The second postulate of Einstein's theory of relativity, which regards the velocity of light *in vacuo* as a universal constant, is considered to be false. J. S. G. T.

2008. *The Vertical Electric Current in the Atmosphere.* **J. G. Mollá.** (Electricidad, 3. pp. 21–24, Sept., 1921.)—The equipotential superficies of the atmospheric electrical field being absolutely horizontal in level and open places, the lines of force, or in other words the path traversed by the ions or electrical charges which are under the influence of this field, will be vertical; that is to say, that where it is a question of the displacement of the electrical charge in the atmosphere or electric current between earth and air the only component to be considered (in calm weather) is the vertical. Hence we speak only of a "vertical current." This current, since ions of each sign exist in the air, will consist of two parts: positive towards the earth and negative in an upward direction. The methods hitherto adopted for determining the value of this current may be reduced to two groups: the direct and the indirect. In the former we observe the dispersion or loss of negative charge experienced by a conducting surface strictly comparable with an element of the surface of the ground. In the latter, the intensity of the current is verified by means of the elements which determine it, according to Ohm's law. Thus, replacing the resistance of the air ρ by its converse, which is its conductivity λ, we get:

$$i = \frac{dV}{dh} \cdot \frac{1}{\rho} = \frac{dV}{dh} \cdot \lambda.$$

It will then be sufficient to determine at a given moment the difference in potential per unit of length in a vertical direction $\frac{dV}{dh}$ and to multiply it by the conductivity λ of the air at the same moment. This latter is the method adopted by the Ebro Observatory. In the apparatus of Elster and Geitel the dispersing cylinder was replaced by a metallic rod 50 cm. long and 0·5 in diameter. The result of this observation being practically the coefficient of dispersion, it is sufficient to divide this by $4\pi(2)$ to arrive at the conductivity of the contrary sign. We thus get:

$$\frac{a \mp \%}{4\pi \cdot 100 \cdot 60} = \lambda \pm = \epsilon (n + k + + n - k -).$$

As in the factors which integrate a, ϵ (the charge of each ion) and k (their mobility) are expressed in C.G.S. electrostatic units, they will contain the expression of the value of λ, which must be taken into account in calculating its product with that of the potential, reducing both to the same units. The vertical current was calculated only on those days on which the curve of the atmospheric potential showed no perturbation between the hours of 8 and 14, i.e. three hours before and after the observation. From these results we get total means as distinguished from the

normal means which are obtained by taking only the values of those days on which, during the 24 hours, there was no perturbation of the potential. The author claims for these researches that they are the most extensive yet carried out. The monthly and annual means from February 1913 to December 1916 are given in a table and, for the sake of comparison, a list is appended of the results obtained in other countries. E. F.

DISCHARGE AND OSCILLATIONS.

2009. *Absorption of Gases in the Electric Discharge Tube.* **F. H. Newman.** (Phys. Soc., Proc. 33. pp. 73–82, 1921.)—The experiments with nitrogen described in Abs. 1093 (1920) have been extended to other substances. Very great rates of absorption were shown by phosphorus, sulphur, and iodine. With hydrogen absorption was also shown by these three elements. L. H. W.

2010. *Spherical Discharge in Gases.* **L. Amaduzzi.** (N. Cimento, 23. pp. 175–189, Feb.–March–April, 1922.)—Describes experiments made in further study of the phenomenon described by Righi who found that in certain circumstances the discharge of a large condenser took the form of a luminous sphere which moved rapidly between the electrodes. The author has studied the conditions under which this phenomenon takes place. J. W. T. W.

2011. *Alternating Current Arc in Liquids.* **S. Bodforss** and **P. Frölich.** (Zeits. f. Physik, 10. 2. pp. 69–79, 1922.)—An investigation was made of the phenomena associated with a.c. arcs between poles of Mg, Al, Cu, and Ag in various liquids. With all four metals, as the arc length is varied, a point of discontinuity is reached where different arc voltages give the same arc current. The general character of the arc voltage—arc current curves for different arc lengths—is very much the same for aluminium and copper, but the curves for magnesium are much steeper for the longer arc lengths than the corresponding ones for Al and Cu. Those for Ag are less steep. The curves show that for small arc lengths (about 0·1 mm.) the arc voltage, before the point of discontinuity is reached, is practically constant as the arc current is increased. But as the arc length is increased the arc voltage falls with increased arc current, and the longer the arc the sharper is the voltage drop for a given current increase. A. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

2012. *Conductivity and Thermo-Electric Power in the Magnetic Field.* **M. La Rosa.** (Accad. Lincei, Atti, 30. ii. pp. 57–60, July, 1921.)—In a paper in N. Cim., vol. 18, p. 26, 1919, the author gave some results on the change, in the magnetic field, of the thermo-electric power of a copper-bismuth couple, and sought to bring these under the ordinary electronic theory of metals from the point of view of changes in the electronic concentration. In Abs. 935 (1921) Prof. Corbino, applying a more direct mode of verification, challenged some of the author's conclusions. In the present paper the validity of Prof. Corbino's method is discussed. A. D.

2013. *The Thomson-Effect.* **O. M. Corbino.** (Accad. Lincei, Atti, 30. ii. pp. 33–37, July, 1921.)—Compares the ordinary method of computing the Thomson-effect on the electronic theory of metals with Lorentz's; and shows that Lorentz uses underlying assumptions which assimilate his conception of electrons in a metal to that of a gas in a porous body. A. D.

2014. *The Hall-Effect in Bismuth Solidified in the Magnetic Field.* **L. Tieri** and **E. Persico.** (Accad. Lincei, Atti, 30. ii. pp. 464–467, Dec., 1921.)—It was expected that bismuth with its particles orientated by solidification in a magnetic field would behave differently from ordinary "isotropic" bismuth. It was found that in a plane parallel to the exciting magnetic field the Hall-effect was notably more intense than with ordinary bismuth, whereas it was less intense in a plane normal to the exciting field. This behaviour is analogous to that of crystalline bismuth, but the anisotropy is greater, being 230 % at H = 4600 and 198 % at H = 2600, instead of about 25 %. A. D.

2015. *Method of Testing Plates from Piezo-Electric Crystals.* **W. G. Cady.** (Optical Soc. of America, J. 6. pp. 183–185, March, 1922.)—The plate to be tested is subjected to light periodic stresses of audible frequency by means of a buzzer, and the quality of the plate is judged by the response in a telephone receiver connected to a valve amplifier. The plates may be tested for either the "longitudinal" or "transverse" effect [Abs. 1647 (1920)]. The buzzer is contained in a wooden box with packing to absorb sound, and a glass rod, about a foot long and $\frac{3}{8}$ inch in diameter, passes horizontally through a hole in the side of the box, one end of the rod pressing against a terminal of the buzzer or some other rigid part that vibrates energetically. A small brass block (E) is cemented to the projecting end of the glass rod, and a $\frac{3}{4}$-inch metal ball, ground flat on one side, fits in a cup in the end of the brass block and is kept from falling out by a fine wire run through a hole in the centre of the ball and turned back round the brass block. The flat face of the ball presses against one face of the quartz or plate under test. On the other side of the plate is a block of metal (G) weighing a few ounces and tapered down at the end nearest the plate, where it has cemented to it a round disc of the material to be tested, cut in such a way as to exhibit the longitudinal effect when compressed. The disc (D) is the same diameter as the flat face of the metal ball (F) and of approximately the same thickness as the plates to be tested. Slight pressure serves to keep D and F in contact with the plate under test. E and G are connected respectively to the filament and grid of the valve, the anode circuit of which contains the usual battery and telephone. A second valve may of course be used, but is usually unnecessary. With the buzzer in operation the plate under test experiences periodic stresses, and a sound will be heard in the telephone if the electric fields in both D and the plate are in the same direction. Reversing the plate then causes the sound to vanish, unless the plate differs appreciably from D in quality. A plate of any size may by this method be quickly explored, and changes in polarity or marked variations in the piezo-electric constant will be readily detected. Roughly quantitative results may be obtained with an audibility meter. A slight modification of the apparatus may be used for the transverse effect. A. W.

2016. *The Thermophone.* **E. C. Wente.** (Phys. Rev. 19. pp. 333–345, April, 1922.)—*Acoustic Efficiency of Thermophones of the Heated Foil or Wire Type.*—Theoretical formulæ are derived for the max. value of the alternating pressure produced within the enclosure of any thermophone when a given alternating current, superposed on a direct current, is passed through the central foil or wire. As an *experimental verification* of the formulæ, an electrostatic transmitter was calibrated for a wide range of frequencies with four thermophones which differed greatly in their physical constants, the formulæ being used to compute the pressures produced. The four calibrations thus obtained agree with each other closely and also with an independent calibration made with a pistonphone.

Methods of Calibrating Acoustical Transmitters.—In addition to the pistonphone, the thermophone is now available. The circuits used in calibrating an electrostatic transmitter are given.

Method of Measuring the Thermal Conductivity of a Gas by Using a Thermophone is Suggested.—It would have the advantage of avoiding difficulties due to convection. AUTHOR.

2017. *Actuation of Spark Coils by Condenser Discharges.* **H. Starke.** (Zeits. techn. Physik, 3. 6. pp. 214–220, 1922.)—The theoretical voltage given by $e = \frac{dN}{dt}$ of the usual induction coil is never reached owing to coupling, self-capacity, resistance, and other effects. The arc formed at the interruptor generally prevents a sufficiently rapid interruption and more or less of the energy is consumed by the arc itself or the primary circuit, thus lowering the secondary voltage. Arcing may be diminished by oil or alcohol immersion, but the best method is by placing a condenser in parallel to the arc and the action is the greater with increase of capacity. A very large condenser acts in the limiting case of a shunt circuit and reduces the voltages of primary and secondary circuits to zero, and there exists an optimum capacity which can be determined from the external conditions for various circuits.

Neglecting losses, the maximum voltage is given by $V_0 = I_0\sqrt{L/C}$ and after interruption of the current oscillations occur with commencing amplitudes V_0 and I_0 and periodicity $T = 2\pi\sqrt{LC}$. The frequency of interruption depends upon the electromagnetic lag and varies with the secondary load. Closure of the circuit must last sufficiently long to attain a certain current value, and hence the higher the voltage and the smaller the self-inductance of the coils the higher may be the frequency of interruption. To prevent the voltages exceeding certain values, regulating resistances are employed, and changes in frequency may be controlled by use of a direct current, or by change of winding turns of the primary.

The attempt to utilise electrostatic, instead of electromagnetic, energy transfer is due to Grisson in 1908, but only brief patent descriptions are available, and little is known of this method in physical literature or laboratory practice. The author has endeavoured to investigate this method by use of a small coil, and the greatest difficulty is to obtain sufficient energy. A device charging a capacity C to a voltage V_0, n times per second delivers an energy $\frac{1}{2}nCV_0$ per second. The author proceeds, after Warberg, to develop the theory of this method, in which a condenser C_1 is combined, via a resistance r and self-induction L, to a condenser C_2. Then if V_1, V_2 are momentary voltages and V the final voltage;

$ir + L\frac{di}{dT} = V_1 - V_2 = U$; $i = -CdV_1/dT = +C_2dV_2/dT$; $C_1V_1 + C_2V_2 = (C_1 + C_2)V$ from which the solution when $\frac{r^2}{4L^2} < \frac{1}{L\sigma}$ is $V = e^{-\beta T}(A\cos\omega T + B\sin\omega T)$ where $\beta = \frac{r}{2L}$, and frequency $\omega = \sqrt{\frac{1}{L\sigma} - \frac{r^2}{4L^2}}$ which (when r is small) tends to $\omega = \sqrt{\frac{1}{L\sigma}}$ where $\sigma = \frac{C_1C_2}{C_1 + C_2}$.

The original conditions are then inserted for original voltages ϕ_1 and ϕ_2 and for the special cases where $\phi_1 = 0$ and $\phi_2 = \phi$, $i_{max.} = \phi_1\omega\sigma$ and $2\phi_1\omega\sigma$ and $V_{2max.} = 2\phi_1\frac{C_1}{C_1 + C_2}$ and $\phi_1\frac{C_1}{C_1 + C_2}\left(\frac{C_1 - C_2}{C_1} + 2\right)$ respectively, i.e. in the case when $C_2 < C_1$ the maximal voltage V_2 is in the second case double that of the first. Hence certain advantages are obtained; for example the primary voltage of the inductor is with condenser discharge, double the terminal voltage of the current source, if the oscillatory circuit has no other resistance or inductance than the primary coil. The advantages of this method are illustrated by diagrams showing the increase in spark length. For example, whilst a spark of only 6 cm. was obtained with the ordinary interruptor a spark of 16 cm. was obtained by the condenser discharge method. The use of electrolytic condensers is discussed, and this method allows the use of fewer primary windings and an iron free circuit as used in wireless work. The author has investigated the method with the Braun oscillograph. Diagrams of connections are shown both for the Grisson circuit, in which the coil is between the commutator and the mains, and other connections in which the coil is between commutator and condenser. In the first method the charging impulse is always in the same direction, and in the second alternative impulses are reversed.

B. J. L.

ALTERNATING CURRENTS AND MAGNETISM.

2018. *Reversible Permeability.* **J. Würschmidt.** (Zeits. f. Physik, 9. 6. pp. 379–394, 1922.)—A continuation of work on the lines followed by Gans and Madelung [see Abs. Nos. 1845 (1908), 147 (1911), 1269 (1912), and 749 (1920)]. The results of these authors are tested and extended by means of work done on permanent magnet steel of high remanence and coercive force. The modified theory of the split ring is employed in standardising a Hartmann and Braun magnetising apparatus.

G. E. A.

2019. *Magnetic Testing of Permanent Magnets.* **J. Würschmidt.** (Zeits. f. Physik, 10. 2. pp. 91–110, 1922.)—The paper describes a method of calibrating Hartmann and Braun's apparatus—used originally for measuring apparent remanences—so that it could be employed for determining the part of the hysteresis curve lying mostly in the upper left-hand quadrant. The true remanence, coercive force, and reversible permeability of a number of short cylindrical bar magnets of different qualities are measured by using the method. G. E. A.

2020. *Application of the Theory of Integral Equations to a Problem of Induced Magnetisation.* **A. V. Bäcklund.** (Ark. f. Mat. Astron. och. Fysik, Stockholm, 15. No. 23 [19 pp.], 1921.—In French.)—Mathematical.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

2021. *Density Determination of Metals and Alloys, Solid and Liquid; Cu, Al, Sn, Cu-Sn, Cu-Al.* **K. Bornemann** and **F. Sauerwald.** (Zeits. f. Metallkunde, **14**. pp. 145–159, April, 1922.)—The buoyancy method is used; the temperature range is generally 680° to 1200° C. In an Heræus furnace stands an iron pipe, about 4 cm. diameter, 50 cm. high, enclosing a test tube of porcelain containing the salt bath, mostly NaCl + KCl, 1 : 1. A quartz thimble is suspended in the bath by a platinum wire attached to one arm of a chemical balance; the material, about 9 cm.^{3}, is placed in the thimble. The perfectly dry salt mixtures were first studied, then the metals and alloys. The specific volume v_s and density d of pure tin were: at 20°, 0·137, and 7·3, at 700° 0·1499 and 6·67, at 1200° 0·157 and 6·4. Electrolytic copper gave at its melting-point of 1084° v_s solid 0·1202, liquid 0·1252; and thus an expansion of 4·2 % on melting; aluminium (less pure) expanded by 6·7 % in melting. Series of determinations were made on the systems Cu-Sn and Cu-Al. In the case of Cu-Sn the compound Cu_3Sn seems to persist in the liquid state In the case of Cu-Al, compounds, either of Cu_3Al or of Cu_2Al or of both, persist in the liquid state within the range 80 to 90 % Cu. The formation of these compounds is accompanied by contraction; there is some slight dissociation. All the fusing alloys expanded. H. B.

2022. *Application of the Optical Method of Determining the Solubility of One Liquid in Another.* **C. Chéneveau.** (Comptes Rendus, **174**. pp. 1019–1021, April 10, 1922.)—When an aqueous solution of an inorganic salt or of an organic compound without action on and insoluble in aniline is placed in contact with the latter, the ratio of the lowering of the refractive index of the aniline to the amount of water dissolved is constant and of the same value for equi-molecular solutions [see Abs. No. 1785 (1922)]. With a salt soluble in aniline, such as silver nitrate, a similar relation holds, provided that the observed lowering of the refractive index is corrected for that due to the dissolved salt. Ionisation is without influence in this respect. T. H. P.

2023. *Conductance of Concentrated Solutions of Sodium and Potassium in Liquid Ammonia.* **C. A. Kraus** and **W. W. Lucasse.** (Am. Chem. Soc., J. **43**. pp. 2529–2539, Dec., 1921.)—In previous papers evidence has been adduced that in these solutions the positive carrier is identical with the positive ion of the salts of the metal, while the negative carrier is apparently the negative electron. At low concentrations the negative electron is associated with ammonia and its speed is comparable in magnitude to normal ions, *e.g.*, 7 times that of the sodium ion; but at higher concentrations its carrying power increases, the velocity of the negative ion is comparable with that of the negative carrier in a metal, and the conductance of the solutions increases enormously. In the present investigation the behaviour of the most concentrated solutions has been studied in detail at the boiling-point of the solvent. The specific con-

ductance in saturated solutions of sodium of potassium rises to $0 \cdot 5047 \times 10^4$ and $0 \cdot 4569 \times 10^4$, the values being practically equal for the two metals at equal concentrations. The equivalent conductance of the saturated solutions is of the same order as that of metals like strontium, or iron, the solubilities being given by the ratios of 5·367 and 4·866 mols. of ammonia for one atom of sodium and potassium respectively. T. M. L.

2024. *Chemical Reactions on Surfaces.* **I. Langmuir.** (Faraday Soc., Trans. 17. pp. 607–620, May, 1922. Gen. El. Rev. 25. pp. 445–454, July, 1922. Chem. News, 123. pp. 225–230, Oct. 28, and pp. 237–239, Nov. 4, 1921.)—The author reviews the evidence for the existence of highly stable adsorbed films. The various methods available for the estimation of the thickness of these films indicate that the latter are monomolecular and that the molecules tend to become orientated on the surface. The mechanism of adsorption and that of chemical reactions on surfaces are discussed, as well as reactions occurring at the boundaries of phases. T. H. P.

2025. *High-Temperature Phenomena of Tungsten Filaments.* **Research Staff of the General Electric Co., London.** (Faraday Soc., Trans. 17. pp. 485–494; Disc., 494–498, Feb., 1922.)—Tungsten filaments are either pure, 99·9 % W, or contain about 1 % of refractory oxide, mostly thoria. The filaments as drawn are ductile, but turn brittle during use. To investigate this, lamps were burned for periods ranging from $\frac{1}{5}$ second up to 600 hours and then broken. In the pure filament the grain, originally small, increases until, after 15 minutes or more, the crystal diameter is about the same as the wire diameter; the average size does not further increase, but the crystal boundaries remain in motion. In the thoriated filament the grain growth is impeded, and the grains are still small after 600 hours; these filaments are stronger and, when spiral, less liable to deformation. As regards chemical reactions, 0·01 mgm. of phosphorus introduced into the bulb has no action, the phosphorus being probably oxidised by residual impurities; 0·04 mgm. increases the grain size, a greater amount has no further effect; the phosphorus probably reduces the thoria. Oxygen attacks the filament, giving yellow or, at low partial pressure, bluish tungsten oxide; hydrogen has no effect. Water vapour is very injurious; it attacks the metal and the liberated hydrogen reduces the oxide formed again so that tungsten is transferred from the filament to the bulb. It also destroys the spirally-coiled wires with which most of these experiments were made; the turns of the spiral in contact with the colder supporting wires thicken visibly, while the hotter (though not the hottest) spirals become thin, stretch and break. Failure may take 600 hours, but in the presence of sufficient water vapour it may occur within a minute. Carbon dioxide forms light blue oxide, monoxide blackens the hottest spirals; hydrocarbons are decomposed under carbide formation and destruction of the filament. Metallic sodium vapour increases the grain size and forms cyanide with the residual nitrogen. In reply to **W. B. Clarke,** the author said that no offsetting, i.e., crystal growth in zigzag (ascribed to alternating currents, here used), had been noticed in the case of the spiral coils; mercury vapour had no effect. The further discussion by **E. Fyleman, A. W. Porter,** and others concerned the problems of crystal growth. H. B.

2026. *Free Path of H-Ions in Hydrogen.* **W. Aich.** (Zeits. f. Physik, 9. 6. pp.372–378, 1922.)—It has been shown by Franck, Knipping, and Krüger [Abs. 648 (1920)], that hydrogen can be ionised by impacts of 17·1 volt electrons. From the work of Lenard and of Franck and Hertz on the free path of slow electrons, the mean free path of the hydrogen ions due to impacts of 17·1 volt electrons can be determined. The mean free path calculated in this way shows that the hydrogen ions thus produced are vanishingly small compared with the dimensions of the molecule, and that consequently such ions must be atomious and not moleculious. A. W.

2027. *Diffusion of Hydrogen, Helium, and Neon through Heated Glass.* **E. Cardoso.** (Accad. Lincei, Atti, 31. i. pp. 28–30, Jan. 8, 1922.)—The author does not consider that diffusion phenomena are sufficient to explain the appearance of helium and neon in discharge tubes containing hydrogen, as suggested by Lo Surdo [Abs. 1027 (1922)]. In some of the experiments referred to, the possibility of the passage of helium and neon from the air into the heated discharge tubes was prevented by surrounding the tubes with an evacuated glass jacket. On the other hand, the presence of rare gases was not observed in the experiments made by Strutt, Merton, and Piutti and Cardoso, even when no protecting jacket was employed. T. H. P.

2028. *Calcium-Barium-Lead Alloys.* **W. A. Cowan, L. D. Simpkins,** and **G. O. Hiers.** (Chem. and Met. Eng. 25. pp. 1181–1185, Dec. 28, 1921. Paper read before the Am. Electrochem. Soc., Sept., 1921.)—An alloy containing 97 % Pb, 2 % Ba, and 1 % Ca, known as "Frary metal" or "Ulco metal" forms an excellent bearing metal. It is made by electrolysing a fused mixture of calcium and barium chloride over molten lead. The heat produced is sufficient to keep the mass molten. The equilibrium diagram of lead and calcium, up to 12 % Cu, as determined by Baar and Donski, is given and a diagram determined by the authors, for lead and barium, is also reproduced. In the latter case a binary eutectic is formed at slightly over 290° C., containing 4·5 % Ba, after which point the liquidus rises rapidly to 6 % Ba; beyond this the alloys have not been investigated. In the ternary system an eutectic is formed at 284° C. and there are some indications that solid solutions are formed containing up to 0·2 % Ca and 0·4 % Ba. The best methods of casting are discussed together with certain peculiar properties of the alloys, including an age-hardening effect. The properties which should be possessed by a good bearing metal are also considered. J. L. H.

2029. *Effect of Impurities on Recrystallisation and Grain Growth.* **Research Staff of the General Electric Co., London.** (Inst. of Metals, J. 27. pp. 107–134; Disc. and Corres., 135–148, 1922. Engineering, 113. pp. 342–346, March 17, 1922.—Abstract.)—A research on the effects of small quantities of impurities in tungsten on the structure developed by annealing. Tungsten containing varying amounts of thoria, alumina, silica, and other oxides, was prepared and drawn into wire which was annealed by passing a current through it. The temperature and time of annealing was observed, and the wire was then submitted to microscopical examination. The conditions which give rise to exaggerated

grain growth are noted—in certain cases crystals 300 times as long as their diameter were observed. An hypothesis is put forward to account for the grain growth. It is assumed that certain factors such as purity, grain-size contrast, strain differences, etc., alter the vapour pressures of adjacent crystals, and that, in consequence, the crystal with the lower vapour pressure grows at the expense of the other. J. L. H.

2030. *Internal Mechanism of Cold Work and Recrystallisation in Cupro-Nickel.* **F. Adcock.** (Inst. of Metals, J. 27. pp. 73–92; Disc. and Corres., 93–105, 1922. Engineering, 113. pp. 305–308, March 10, and pp. 340–342, March 17, 1922.)—Commercial 80–20 cupro-nickel was reduced, by rolling, by approximately 50 %, 75 %, and 88 %, and the products were examined microscopically. They were then annealed at various temperatures and examined once more. The hardness was also measured on these specimens, and it was found that, until new grains appeared under the microscope, the hardness fell but very slightly; during the temperature interval in which both old and new grains were visible, the hardness fell rapidly, and when only new grains were visible, the hardness fell much more slowly with rise of annealing temperature. Samples annealed at temperatures just too low to bring about visible recrystallisation, showed etch-bands and horizontal striations much more clearly than the unannealed specimens. The new grains which appeared in the specimens treated at the proper annealing temperature were always found associated with: (*a*) Etch-bands which represented the traces on the surface of the specimen of the sloping slip-planes; (*b*) striations running parallel to the direction of rolling; or (*c*) boundaries of deformed grains and mechanical inclusions. J. L. H.

2031. *Equilibria in the Systems: Iron; Carbon; Oxygen and Iron; Hydrogen; Oxygen, and the Free Energies of the Oxides of Iron.* **E. D. Eastman.** (Am. Chem. Soc., J. 44. pp. 975–998, May, 1922.)—The data are collected and tabulated of various measurements which have been made on the equilibria between CO_2, CO, and the different oxides of iron. Conclusions are drawn as to the extent of the mutual solubilities of the different oxides and metallic iron at different temperatures and the conditions for the separation of C and formation of iron carbides are determined. The controlling factors for the formation of univariant and divariant equilibria are defined. It is shown that ferrous oxide has a definite solubility in iron which modifies many of the earlier conclusions drawn from equilibrium measurements. The individual results of different investigations are compared graphically and are in sufficient agreement to permit the use of equilibrium constants and free energies based on them. These constants are tabulated at definite temperature intervals and the equilibrium data are checked by means of thermal calculations. Constants obtained from different equilibrium measurements made with oxides of iron and H_2 do not agree sufficiently to enable the free energies and heats of formation to be deduced in these cases. J. N. P.

2032. *The Ultramicroscopic Appearance of Colloidal Carbon.* **H. Lachs.** (J. de Physique et le Radium, 3. pp. 125–127, April, 1922.)—Concentrated hydrosols of amorphous carbon prepared by Sabbatani's method when examined under the ultramicroscope using a paraboloid condenser show, with some of the particles, scintillation effects. On partially drying the

material until many of the particles become immobile, clusters appear of very small colourless needles which produce characteristic light effects. Dilute colloidal suspensions of carbon exhibit no unusual properties and the submicron particles give effects similar to those obtained with colloidal silver rather than typical Brownian movements. The scintillating property with carbon is unaffected by temperature and is unchanged by long standing. The same phenomenon is obtained with colloidal PbI_2 and HgCl when freshly prepared but, on standing, the effect in these cases is diminished and followed by the development of long crystals. The scintillation is attributed to the dispersion of light due to the property of double refraction which the hydrosols under investigation exhibit while in motion. The movement of the liquid causes the crystal micelles to arrange themselves longitudinally to the direction of flow and to have anisotropic properties while, when at rest, the hydrosol is isotropic. With colloidal V_2O_5 the scintillation phenomenon which is also observed under the ultramicroscope is modified when subjected to cataphoresis in accordance with the orientation of the particles with their crystal axes parallel to the lines of force. J. N. P.

2033. *Apparatus for Direct Resistance Heating to High Temperatures under High Pressure.* **F. Sauerwald.** (Zeits. Elektrochem. 28. pp. 181–183, April 1, 1922.)—By passing an electric current through a rod of conducting material such as carbon or tungsten, temperatures up to 2000° C. are produced, while the material can be subjected to a high mechanical pressure and surrounded by any desired gaseous atmosphere. Each end of the conducting rod is held by means of a clamp and slot fitted in a plug which closes the end of a brass tube through which water flows for the purpose of cooling. One of the electrodes is insulated from the furnace enclosure by means of a layer of asbestos. Plungers are admitted through the walls of the body of the furnace in an axis perpendicular to that of the case and enable mechanical pressure to be applied to the centre of the heated rod.

The apparatus has been applied for examining structural changes in powdered tungsten when submitted to heat and pressure and also for the investigation described in the next abstract. J. N. P.

2034. *Behaviour of Carbon at High Temperatures.* **F. Sauerwald.** (Zeits. Elektrochem. 28. pp. 183–185, April 1, 1922.)—In the apparatus described above, a carbon rod 16–36 mm.^{2} cross-section and 6 cm. long, after electro-coppering the ends to diminish the contact resistance, is mounted in the water-cooled clamps, surrounded by an atmosphere of hydrogen, and by means of a current of 2100 amps./cm.^{2}, the temperature is raised to that of the carbon arc and measured by an optical pyrometer sighted through a side tube. Impure forms of carbon, on account of fracture, did not enable the highest temperatures to be reached. It is considered, in the case of rods of 36-mm.^{2} cross-section that, on account of the increased cooling from the outside accompanied by the negative temperature coefficient of resistance of carbon, the temperature in the central layers of the carbon will be higher than the outside by 100–200 deg. C. In all typical experiments, on approaching the temperature of the arc, the circuit suddenly broke, due to transverse rupture of the rod which at this point was seen when cold to possess a bulge and a longitudinal cavity in the centre pointing to volatilisation of the carbon from this

zone. Congealed globules of carbon of a diameter up to 0·5 mm., occurred as a deposit on the outside surface of the rod and were found to contain an ash content of 2·8 %, while the original graphite possessed only 0·08 %. It is considered that the temperature difference between inner and outer layers during heating causes distillation of impurities to the outer layers, the melting-point of which is lowered through the formation of carbides. The difference in the composition of this product from the pure carbon composing the similar globules obtained by Ryschkewitsch is attributed to the longer duration of the experiment in the latter case which enabled the carbides at first formed to decompose. Apart from this effect, there is no indication of melting of the carbon in any part of the rod such as is obtained with a tungsten rod when treated similarly whereby a separation of a fused zone in the centre is obtained. A softening of the carbon on heating to 2000° C. is demonstrated by applying pressure laterally by the plunger, but this is not considered to be connected in any way with fusion of the carbon.

E. Ryschkewitsch. (*Ibid.*, pp. 185–186, April 1, 1922.)—The difference between the results obtained by the author and those of Sauerwald is attributed to the better thermal insulation of the carbon in the former case which thus involved the use of a lower current density and a lower temperature gradient in the interior layers of the rod. In this way fusion of the carbon throughout its whole section became apparent. The experiments are not considered to establish the claim of Sauerwald that the melting-point of carbon is lowered by the presence of impurities.

J. N. P.

2035. *The Electrolytic Valve Effect.* III. *Maximum Potential Difference and Ionic Concentration in Aluminium Cells.* **A. Günther-Schulze.** (Zeits. f. Physik, 9. 3. pp. 197–200, 1922.)—Within ordinary concentration limits of the electrolyte, 0·05 to 1 N, a decrease of the ionic concentration by 1 per cent. increases the maximum potential by 0·24 per cent. The present paper concerns very small concentrations and a pure aluminium of 99·6 per cent. (anode rods of 6 mm. diam.) surrounded by Al-foil in mixed solutions of borax and boric acid. With increasing dilution the potential V rose to 1890 volts, the relation being, at low ionic concentrations, expressed by $V = 514 \cdot 5 \log v - 330$ volts, where v is the ionic dilution in litres per gram-equivalent.

IV. *Decomposition of the Electrolyte by the Sparks at Maximum Potential.*—During the formation the potential rises first slowly and then rapidly to a maximum, at which the sparks, so far silent, become noisy and brilliant, each spark projecting a jet of gas from the anode. The amount of gas so generated far exceeds that of the ordinary electrolysis. With Al in mixtures of borax and boric acid a max. potential of 1890 volts was reached with currents i of 100 milliamps and 10 times more gas was collected than would correspond to these currents; the excess gas evolution became more marked at 1150 volts. The cells have to be cooled; with efficient cooling the gas excess is, for short periods of an hour or so, proportional to i^2; with inefficient cooling the excess may altogether vanish. The gas consists of electrolytic gas with an excess of hydrogen, and the excess seems due partly to the formation of H_2O_2. The potential changes very little in spite of the violent sparking. Similar observations were made with tantalum electrodes in ammonia, acetic acid, formic acid; in these cases the gas excess $u = b(i - i_o)$ where i_o is the residual

steady current. High potentials seem to be required to produce the gas excess. In the presence of anions of the heavy metals, Cr, Fe, Mn, Pt, the maximum potentials are low, and a gas excess is not observed. H. B.

2036. *Jets of Protons.* **A. Günther-Schulze.** (Zeits. f. Physik, 9. 4. pp. 246–250, 1922.)—The following explanation is suggested for the gas excess observed in electrolytic valves [see preceding Abs.]. The valve effect is due to a formation of an effective layer of gas, of exceedingly small thickness, within the pores of the aluminium hydrate. The layer forms a condenser; the dielectric constant ϵ of the medium is unknown, but even if ϵ were as high as 5, the field strength in the layer would be enormous, of the order of 20,000,000 volts/cm. At the maximum potential now, it is suggested, hydrogen nuclei without electrons (protons) are produced within the layer and are driven by the field intensity into the electrolyte, the molecules of which they may break up, for instance, in the case of ammonia. The author calculates the ranges of these protons; he finds 79 $\mu\mu$ at 700 volts in formic acid and 3·3 $\mu\mu$ at 1890 volts in water. The water molecule is very difficult to disrupt; the hot water molecules are hence vaporised (unless sharply cooled). When direct currents give no gas excess, alternating currents of 50 cycles may yield a large excess with two equal Al electrodes. H. B.

2037. *Electrochemical Investigation of Mixed Crystals of Gold-Copper.* **R. Lorenz, W. Fraenkel,** and **M. Wormser.** (Zeits. anorg. Chem. 118. pp. 231–253, Sept. 5, 1921. **Wormser,** dissertation, 1919.)—The phenomena taking place at polarised electrodes and the decomposition potentials of the electrolyte are intimately connected, the former depending upon the discharge of an electrode, the latter upon the process of charging. The phenomena are complicated by gases and the formation of solid phases (*e.g.*, oxides). The experiments were made with electrodes of copper, gold, and series of their alloys (0·1 to 0·8 atom of gold) in sodium hydrate, to which ammonium was added, and in copper sulphate; the copper was pure electrolytic, rolled and reheated, or copper-plated sheet metal; hydrogen was passed through the solutions to remove atmospheric oxygen. Anodes of pure copper and of alloys containing less than 0·2 atom of gold show two humps in the current-potential curve and two arrest-points, corresponding to the potentials of definite oxides, *e.g.*, in the polarisation-discharge curve; when the gold contents increased above 0·2, there is only one hump and one arrest-point. In accordance with Tammann it is further found that the decomposition potential of the alloys in copper sulphate increases proportionally to the gold-content up to 0·26 Au; alloys richer in gold have the potential of gold itself. H. B.